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PORT LYTTELTON, NEW ZEALAND.

A PUBLIC work of great importance to commercial navigation, and which may facilitate direct intercourse between England and the Southern (often called the Middle) Island of New Zealand, has recently been completed with remarkable success. That part of the island formerly styled the Canterbury Province, of which the flourishing city of Christchurch is the capital, has Lyttelton for its chief seaport, with a large natural harbor partially sheltered by the heights of Banks Peninsula to the south, and Godley Head to the north, but which was shut out from the inland plains by lofty hill ranges. The late Provincial Government of Canterbury, which has, with all the other governments of the several provinces in both islands, been superseded by the act of political centralization passed in 1875, showed a wonderful degree of enterprise and courage in overcoming this obstacle, as well as in other material improvements. So far back as 1860, only ten years after the arrival of the first party of settlers in Canterbury, the Provincial Government, of which the late Mr. W. Sefton Moorhouse was then superintendent, began the construction of a railway, with a tunnel cut 2,838 yards in length through hard volcanic rock, amid the cheers of a large assemblage of spectators. The Christchurch Volunteer Artillery and the Lyttelton Naval Brigade formed a guard of honor to his Excellency the Acting Governor. After this ceremony, the Chairman of the Harbor Board, Mr. Peter Cunningham, entertained a company of seven hundred gentlemen at luncheon, the chief guests being Sir James Prendergast, the Acting Governor; Sir Julius Vogel, late Agent-General in London and formerly Prime Minister of New Zealand; the Bishop of Christchurch, the Hon. W. Rolleston, the Hon. E. Richardson, the Chairmen of the Wellington, Dunedin, Oamaru, and Timaru Harbor Boards, and the Mayor of Christchurch. The President of the Chamber of Commerce, Mr. W. D. Meares, gave an account of the rapid commercial progress of this (Canterbury) part of New Zealand, the exports of which in 1881 had risen to the value of £1,539,000, having nearly trebled in about ten years, while the imparts show an equal rate of increase. The amount of shipping that enters this port is exceeded only by the port of Auckland, being nearly the same as that of Dunedin (Port Chalmers), the chief port of Otago.

We give an illustration of the harbor of Lyttelton, and the scene at the opening of its new graving dock, which is one of the largest and most commodious in the southern hemisphere, or in any of the British colonies. Its length is 450 ft.; width at entrance, 62 ft.; least width where the ship's bilge would be, 54 ft.; width at the top, 82 ft.; width on the floor, 46 ft.; and depth of water on the sill, 23 ft. The floor is of stone bedded in cement 2 ft. thick, upon concrete 2 ft. 6 in. thick; and the sides, divided into twelve steps, are of similar materials, the whole perfectly solid. More than 100,000 cubic yards of rock had to be excavated for this dock, which is situated in the south-west corner of the inner harbor. It is closed, not by gates, but by an iron caisson 62 ft. long, 19 ft. broad in the upper part, and 28 ft. deep, constructed by Messrs. Kay & Stephenson, of Christchurch, under the direction of Mr. Napier Bell, the engineer. This caisson is divided into three compartments, which are ballasted with pig iron, and which can be filled with water at discretion to make it sink, broadside on, at the invert of the dock; but when the dock is to be reopened, the caisson is emptied of water by its pumps, and is removed to moorings outside. The graving dock will enable ships of a thousand tons or more to be easily cleaned or repaired; and it will be provided with all the needful workshops, and with lines of rail for the conveyance of goods or materials. A patent slip, taking vessels of 590 tons, is also to be erected, so that Port Lyttelton will offer the most complete accommodation to shipping direct from England or from any other part of the world. At the port of Timaru, a hundred and twenty miles south or Lyttelton, a breakwater is being constructed which will make another safe and convenient harbor for the increasing maritime traffic of that fine agricultural district.—*Illustrated London News.*

PORT LYTTELTON, NEW ZEALAND, WITH THE ENTRANCE TO THE NEW GRAVING DOCK.

connecting Port Lyttelton with Christchurch; and this railway, through the tunnel, was opened for traffic in 1864. There are now lines of railway from north to south, with many branches, in Canterbury and Otago. A commission was also appointed, in 1863, for the improvement of the harbor, Mr. W. B. Bray, C.E., a pupil of Robert Stephenson, being its chairman; and the result was the construction of a breakwater, and of quays and wharves, much enhancing the safety and convenience of the port. Mr. Walter Kennaway, now Secretary to the Agent-General for the New Zealand Government in London, then held the office of Secretary for Public Works in the Canterbury Government, and signed the contract for the moles and breakwater. In 1877, the Lyttelton Harbor Board was constituted, by an Act of the General Assembly of New Zealand; but the Canterbury Provincial Government deserves the credit of having already, before it ceased to rule in that part of the colony, resolved on the construction of docks. The Superintendent of the Province after Mr. Moorhouse was the Hon. W. Rolleston. The Harbor Board, of which the Hon. E. Richardson was the first chairman, in 1879 undertook to provide a graving-dock which would afford facilities for repairing and cleaning large ships. Mr. C. Napier Bell, C.E., was appointed engineer; and the tender of Messrs. Ware & Jones, as contractors, was accepted in October of that year. They have finished their work, the contract price of which was nearly £92,000, in a manner perfectly satisfactory to the Board; and the new Graving Dock was opened on Jan. 3 this year, by the Acting Governor of New Zealand, Sir James Prendergast, with hearty congratulations and hopeful predictions for the future of Port Lyttelton. A fine vessel called the Hurunui, Captain Hazlewood, of 1,012 tons, one of the New Zealand Shipping Company's fleet, was the first to open the dock, breaking a ribbon stretched across the entrance,

A SOLID silver chalice, inlaid with gold, has been found near Greensburg under a decayed log.

ON THE CARE AND MAINTENANCE OF BRIDGES.*

By THEODORE COOPER, M. Am.Soc.C.E.

THE rusting or corrosion of wrought-iron at ordinary temperatures is a very important matter of consideration.

The example given by Mr. Macdonald † of the corrosion of an iron rod set in sulphur is not an uncommon one; numerous instances, however, can be given where iron set in sulphur has corroded. The explanation, to the writer's mind, is a simple one. There is no chemical action between pure sulphur and iron at ordinary temperatures, these two elements only uniting at high temperatures—above red heat. But ordinary commercial sulphur generally contains sulphuric and sulphurous acids, produced by the oxidation of the sulphur during its process of sublimation. These acids are the immediate corroding agents when the impure sulphur and iron are in contact.

Such sulphur should be thoroughly washed before being used.

In general, the rusting or corrosion of iron only takes place in the presence of an acid and moisture.

In dry air at common temperatures, or under pure water free from air and carbonic acid, iron does not oxidize. Neither does it oxidize in dry carbonic acid gas; nor to any great extent, if at all, in damp oxygen. But in the presence of moisture and many acids the corrosion takes place readily and continuously.

The most common agent toward corrosion is carbonic acid gas.

Prof. Calvert found that damp air with a slight addition of carbonic acid produced a rapid oxidation; the process being, first, a production of protoxide of iron, changing to the carbonate and then passing to the hydrated oxide or ordinary rust. Though the carbonic acid was the active agent in bringing about the combination, the carbonate of iron remained in small quantity—an apparent process of transfer or disposing influence.

As our atmosphere contains carbonic acid gas and aqueous vapor, and as all natural waters contain air and generally carbonic acid in solution, the rusting of iron is universal. It varies, however, in the degree of rapidity according to the conditions of the special location; the dryness of the air in certain regions making the action an exceedingly slow one, while in others the excess of moisture and gaseous acids produce an exceedingly rapid corroding action. In tubular bridges, tunnels covered with iron girders, and the overhead parts of bridges, the iron work is especially subject to corrosion, due to the excessive amount of moisture (condensed steam), carbonic acid, and frequently sulphurous acid discharged upon the exposed surfaces from the locomotives.

While the sulphurous acid, if present, is a very active agent

* A paper read before the American Society of Civil Engineers, 1882.

† In a verbal discussion of the paper on the care and maintenance of bridges.

in promoting corrosion, the greatest factor is undoubtedly the carbonic acid gas. An analysis of a sample of rust taken from the Conway bridge gave:

Sesquioxide of iron	93·094 per cent.
Protoxide "	5·810 "
Carbonate "	0·900 "
Silica	0·196 "

Mr. Wm. Kent found in rust taken from a Pennsylvania Railroad bridge, where it was exposed to the action of the escaping gases, carbonic acid in considerable quantities, but only traces of sulphuric and sulphurous acids.

Under fresh or under salt water the corrosion of iron is largely influenced by the presence and amount of air and carbonic acid gas.

The action generally appears to be greater where the iron is alternately wet and dry.

The caustic alkalies and alkaline earths prevent the oxidation of iron by neutralizing the acids. Iron, therefore, does not corrode in alkaline solutions or when embedded in lime.

The testimony in regard to the action of a thin coating of lime whitewash upon iron is contradictory. The writer has seen many cases where whitewash has corroded iron rapidly; others testify to its thorough preservative qualities. The difference may consist in the addition of other ingredients to the solution; for example, it is often customary for whitewashers to add common salt to the lime solution to increase the hardness of the coating; again, others add glue or similar material to the lime to increase its adhesive qualities. The one containing salt would undoubtedly corrode the iron, and the other with the glue would not do so. Whether a thin layer of lime only, after the lime had taken up its full equivalent of carbonic acid, would continue to act as a preservative, is doubtful; for from its hydroscopic character it would readily convey moisture charged with the destructive acid in to the surfaces of the metal.

cause, it was located upon the man who sorted and wrapped the knives into packages. Everything he touched was found to rust, from the peculiar acid character of his skin exhalations.

Similarly, it is well known that some persons cannot carry pocket-knives or bright iron articles, as keys, etc., about their persons without their becoming very rusty.

The rusting of iron proceeds with great rapidity after it has once commenced, because the rust of iron is a ready absorber of moisture and gases, and it thus constantly conveys new elements of destruction in to the yet unchanged metal.

It is to this fact that the great difference in the rusting of used and unused rails, machinery, and tools is due. The jars and vibrations to which the one is subjected keep the surfaces clear of accumulated rust, that would act as storage reservoirs for the corroding elements.

There is often much misconception in regard to the amount of iron contained in a certain thickness of rust. Dense, compact rust may contain enough iron to equal one-fourth or one-fifth of its thickness, but the looser and more common kind of rust will not contain over one-eighth of its thickness in pure iron. In other words, rust one-quarter of an inch in thickness will contain from one-sixteenth to one-thirty-second of an inch of iron, according to the density of the rust.

The preservation of iron from corrosion is a subject of vast importance, and has given rise to many expedients more or less effective, such as alloying iron with other metals, as chromium, tin, or copper, arsenic, etc., to obtain a less corrodible metal; plating the surfaces with other less oxidizable metals, as nickel, tin, copper, silver, or gold; coating with zinc, a metal that is readily oxidized upon the surface, but whose oxide, when formed, becomes a protection to any further oxidation (when not subject to other acids than carbonic acid gas); coating with fused mineral enamels; covering with lacquers; coating with magnetic oxide of iron by

lodgment of water and dirt, the amount of surface exposed to corrosion, the number of parts subject to adjustment, and the facility of repair and renewal of the ties or wooden floor.

The writer has seen bridges recently constructed, and which have been accepted by engineers of an important railroad, that have their wooden floors built into the iron work in such a manner that a broken or decayed tie cannot be replaced except by removing the whole bridge floor.

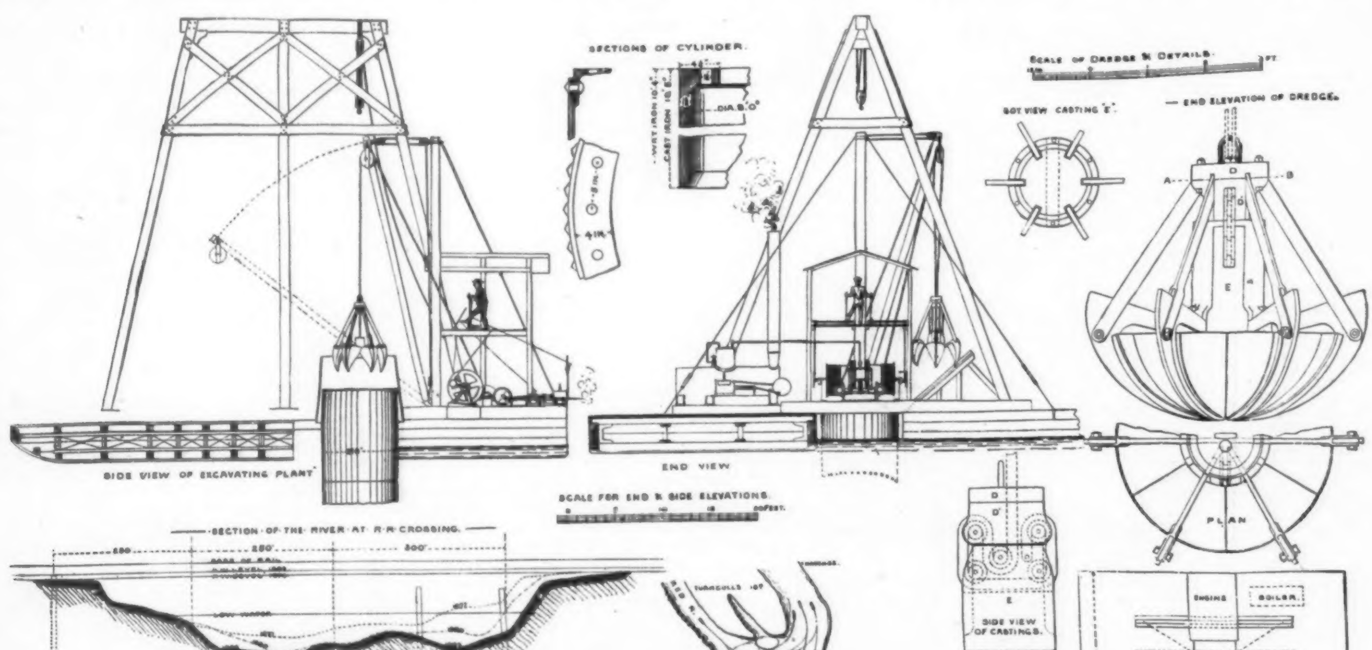
The inspection of bridges should be something more than the superficial examination of the track walker. To know that every member is doing its duty properly, and to discover the reason when such is not the case and the remedy to be applied, requires the supervision of a more intelligent class of men than usually are delegated to this work.

Of hundreds of bridges examined during past years by the writer, it would be safe to say that not more than ten per cent. of them were found in a condition to do their best duty; many were badly neglected, and some positively dangerous; all showing a positive want of intelligent inspection and supervision. It would undoubtedly be true economy, and certainly a just duty to the public, for every railroad to have its bridges carefully and intelligently examined at least once a year by a special expert. If it accomplish no other end than to check and educate the ordinary local inspectors in a proper execution of their duties, it would pay for the expense.

FOUNDING PIERS IN THE ATCHAFALAYA OF LOUISIANA.

THE accompanying plans illustrate the methods adopted in sinking the iron cylindrical piers for the bridge now being erected for the Texas and New Orleans R.R. over the Atchafalaya River, near its junction with the Red River, in Louisiana.

This bridge being located in the lowland region of the State, where the soil is alluvial and of a depth almost limit-



FOUNDING PIERS IN THE ATCHAFALAYA OF LOUISIANA.

As to hydraulic cement, the evidence is not so positive. Mr. Thos. C. Clarke, M.Am.Soc.C.E., says, in his report upon the Niagara bridge, that on uncovering the anchorage links he found the iron as perfect as when put there, without the slightest sign of rust, though the mortar was saturated with moisture and the whole foundation evidently surrounded by water-bearing strata of rock. Gen. M. C. Meigs says he found a wrought-iron pipe, laid in cement concrete, honeycombed and leaky after twelve years' time, and he learns from plumbers that in their experience American cements corrode iron.

This different testimony in regard to the action of cements may possibly be explained by the different circumstances of each case—such as the relative compactness and depth of the cement in which the iron is embedded.

There is a possibility, however, that in certain cements the silicates may be soluble in water, and thus furnish the acid agent toward corrosion. Mineral wool made from furnace slag very closely approximating the composition of hydraulic cements has been found in certain cases to corrode iron very rapidly. It was claimed that this was entirely due to the hygroscopic character of this material, but recent instances reported to me would appear to lead to the belief that the wool in the presence of water not only corrodes the iron, but also disintegrates and hardens into a solid mass.

Wet coal ashes corrode iron very rapidly.

Mr. Wm. Metcalfe, M.Am.Soc.C.E., states that a wrought-iron pipe buried in coal ashes was completely eaten away in one year's time.

As a curious instance of the slight causes which promote oxidation, the experience of a manufacturer of fine cutlery was related to me. He found at one time a large portion of his goods being returned to him as in damaged condition; instead of the bright clean surfaces for which such articles are noted, he found rusty, deeply oxidized blades. After much anxiety and watching to determine the cause, whether it was damp paper, the ill-will of some of his agents, or other

the processes of Barff or Bower, by subjecting to high temperatures and the presence of moisture; and lastly, the use of paints of innumerable characters.

For general engineering structures, the coating given to iron surfaces for their protection against corrosion must be not only moderate in cost, but of such a character as to be readily renewed when removed by accident or design. It must also differ from zinc in being able to resist the corroding action of sulphurous acid gas and the chlorides, in locations where these may occur.

This practically reduces us to the use of paints (using this term to include not only the paints proper, but varnishes, oils, and other materials applied in a liquid form). The relative merits of the paints depend upon their durability, adhesiveness, and imperviousness. The cracking of the paint and want of adhesion produced by too rapid drying of the paint, and the want of adhesion due to the presence of rust upon the surfaces of the iron, are the most frequent causes of failure in the better classes of paints. All rust should be carefully removed from the surfaces of the iron before painting; a coat of raw linseed oil then makes an excellent covering for the surface—elastic, perfectly adherent, and a good durable substratum for future coverings. In order to get our iron work out of the shops quickly and in a condition to be handled, we resort too often to quick-drying paints, to the future injury of the work.

As to the pigment to be used for the covering of this substratum, red lead, oxide of iron, etc., each have their own advocates.

The maintenance of iron bridges is so dependent upon the detail of their design, and the method and character of the inspection, that it is very important, both from points of economy and of safety, that the supervision of these points should be given to competent men.

The original design affects the maintenance and care of our bridges, not only by the form and proportions of the structure and its details as to strength, but also as it affects the accessibility for cleaning and painting, the freedom from

less, subject to rapid and extensive scouring action, deep foundations were absolutely necessary for safety. No suitable stone was to be found within any reasonable distance, and, unless used in connection with an expensive caisson, was not adapted to the site; hence iron cylinders were adopted for the piers and abutments.

It was the original intention to use compressed air in sinking these cylinders, it being expected that a safe foundation could be obtained at a distance of 90 feet below the ordinary water surface; but later investigation into the rate of scour proved that a depth of 125 feet would be required; which, being beyond the "limit of safety" of previous pneumatic experience, made this method unadvisable.

Compressed air being abandoned, a modification of the Milroy excavator was suggested by Mr. John F. Andersen, the superintendent of the company, and finally put into practice with the success shown.

The cross-sections of the Atchafalaya River at and near the bridge are by no means the least interesting of the accompanying diagrams, especially when taken in connection with the possibility of the Mississippi River finding its way to the Gulf at some future time by this route. This very imminent possibility is the problem that is now set before the Mississippi River Commission, and the diagrams would seem to prove that some speedy action in the matter was necessary.

At the bridge site, the general cross-section shows first a layer of driftwood, 10 feet in depth, troublesome to penetrate, then about 30 feet of hard blue clay, then sand and clay mixed for 10 feet more, and finally sand to an unknown depth.

The cylinders used were 8 feet in outside diameter; below the level of the river bed they were made of cast iron $1\frac{1}{4}$ inches thick, in lengths of 10 feet 4 inches, the sections secured together by inside flanges, and bolted by 1 inch bolts spaced 5 inches apart. Above the river bottom the cylinders were made of wrought iron riveted, $\frac{3}{8}$ inch thick, with angle-iron flanges, bolts, and spacing same as above.

The "plant" for handling the cylinders and the excavator is fully shown on the plan. It was erected upon two wooden barges, each 60x24 feet, secured together at one end so as to leave a space of 9 feet between them; the engine was 50 H. P.

As remarked before, the excavating apparatus is a modification of the Milroy excavator, used in England and India, but more compact and simple in its action than its English prototype. The capacity of the full bucket is two-thirds of a cubic yard. Its general appearance is illustrated by the plans shown. Describing its working from an inspection of the drawings merely, as we understand them, it is as follows: The excavator is provided with two chains, one secured to the eye-bolt in top of the casting, D, the other, passing through D and around a series of rollers or shears, as shown on "Side View of Castings," is fastened to the lower casting, E. The hoisting engine has two drums, by which these chains can be manipulated independently. The six arms carrying the bucket-sections are secured by pins to the lower casting, E, and are so connected to the upper casting, D, by the forked levers that by raising the top casting by its appropriate chain, the bottom one remaining stationary meanwhile, the arms will be thrown out and the bucket opened; bringing the two castings together by lifting the lower one will, on the other hand, close the bucket and allow its contents to be hoisted. A double-sheaved boom-derrick lowers and hoists the bucket, and swings it to one side so that it may discharge its contents into a chute. Three men furnish all the necessary labor.

The bridge to be erected on these piers when finished will be 800 feet long, made up of two 250 feet spans, and draw-span 300 feet long. Actual work was commenced Aug. 1, 1882. Two 8 foot cylinders will form each permanent span pier. The arrangement of the pivot-pier is not given as yet.

Reverting to the cross-sections illustrated, that one taken 1,000 feet above the bridge crossing shows plainly the very marked changes that have taken place in the area of waterway between the dates named. The average increase in depth of channel is 80 feet in 20 years; and in one portion 50 feet has been gained in two years. Mr. Andersen gives as a potent reason for change in his plans an increase of 30 feet in width and 8 feet in depth as the work of one year's floods upon the river contour. As the river deepens, the banks are undermined and cave in. It is this action that causes the abrupt bench shown on the lower diagram, to the right, and the sloping of the same bank in the upper cross-section. The right-hand shore cylinders were pushed out of the perpendicular by this movement of the bank. For the original plans and the data upon which this sketch is based we thankfully acknowledge our indebtedness to Mr. John F. Andersen, the present Superintendent of Bridges for the American Railway Improvement Co., of which Gen. G. M. Dodge is the President. Mr. Andersen was formerly Superintendent of the Hudson River Tunnel in this city, and has had much experience in this peculiar line of engineering.—*Engineering News.*

ON THE USE OF CONCRETE IN MARINE CONSTRUCTION.

FRENCH engineers justly deserve the distinction of being foremost in the application of concrete in marine works, and perhaps no better example of their skill and ingenuity can be selected than the method employed at Port Napoleon, Brest, in the manipulation of large artificial blocks. In this case the weight of each block was about 100 tons, and they were all built above high water, each on a separate timber platform, or carriage, resting on a slip with three longitudinal ways or runners of timber about 7 ft. 9 in. apart, centers, the upper part of which was rounded to receive bearing pieces hollowed out to the same curve to prevent lateral motion attached to the platform, which was thus enabled to slide freely down the ways into the water. The blocks, when sufficiently consolidated, were launched as required by means of two endless chains traveling the whole length of the slip, one on each side of the block. After submersion, and when the tide had risen to a convenient height over the block, it was lifted by an iron float (see Fig. 1) and carried while under water to its destination in the work; when relieved of the weight, the timber carriage floated to the surface and was transferred to the head of the slip ready to be used for another block. The slip was about 380 ft. in length, and could accommodate 28 to 30 blocks, so that the work was capable of being carried on with little interruption.

The ways had an inclination of 1 in 16·6 or about ¾ in. per foot. The blocks varied in size, averaging about 16 ft. 6 in. long by 9ft. 10 in. broad, and 8 ft. 10 in. high; they were at first built inside an inclosure embanked to a height of 6 ft. or 7 ft. above low-water zero; this, however, involved so much tidal work that it was abandoned in favor of the slip.

In lifting the blocks ordinary chains were at first used, fitting into grooves built in the sides and bottom; this method, however, was found inconvenient and did not permit of the block being relifted in case of necessity. Four tee-headed rods were, therefore, substituted for the chains, suitable rectangular openings being formed vertically in the block, the tee-heads bearing on hard wood pieces covered with sheet iron on the under side, and built into the block about 1 ft. from its base, at which level small chambers were formed to permit the rods being turned when lifting or letting go the block. The cubic contents of the blocks averaged about 53 cubic yards each and weighed in air, as before stated, about 100 tons; they were built of rubble masonry set in cement mortar consisting of 1 part cement to 4 of sand.

Four comparatively small iron hopper floats were employed on the work for depositing the rubble required for the foundation mound, and for removing dredged material, etc., the hopper doors being so arranged that when open their lower edges did not project beyond the bottom of the float. One of these floats was also utilized for lifting and setting the concrete blocks; their dimensions are given as follows:

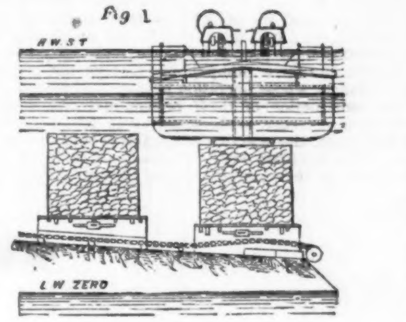
	ft.	in.
Length	92	0
Breadth	16	6
Draught, light	1	8
" with 125 tons	4	9

In lifting the blocks four balks of timber were placed on the deck of the float, connected in pairs and fixed over two pairs of openings through the float, each pair of balks having a clear space between them of about 15 in., so as to permit the free passage of the suspender bars and chains; the balks carried four winches with pitch chains and pinions worked by screws. On a rising tide, and when the water had risen sufficiently high, the float was accurately placed over the block to be lifted, the four tee-headed bars were lowered into the vertical openings in the blocks, the chains were then tightened, and the block gripped. As the tide rose the float was immersed until the displacement equaled the weight of the block, which would be about 55 tons in sea water, the float then drawing about 3 ft. The float with the block attached was then towed to the position the latter was intended to occupy, and when the tide had fallen sufficiently the block was carefully lowered into its place; it was found that after a little practice the blocks could be laid with great precision in two tiers one over the other. Fig. 1 shows the float in position in the act of lifting a block. Fig. 2 represents a cross section of the quay wall.

One float only was used with the blocks, and in order to insure accuracy in ranging and setting, advantage was taken of the most favorable states of the tide. Under these circumstances, it was sometimes necessary to work by night, and the average rate at which the blocks could be deposited was thirty per month, which represents 36,000 tons, or (taking 16 cubic feet equal to 1 ton) about 21,300 cubic yards of material built into the structure under low water per annum, which is equivalent to 120 tons, or about 70 cubic yards per day, allowing 300 working days to the year; about 50 lineal feet of quay wall, including superstructure and blockwork, was completed per month.

It is evident, however, that the system is capable of being employed on a much larger scale by using several floats, which would not only enable the work to proceed with much greater rapidity, but permit far more advantage to be taken of fine weather, thus increasing both the facility and economy of the necessary operations.

Fig 1



The lifting float used at Brest was capable of carrying blocks of nearly double the weight of those adopted, and it does not appear that the weight need have been restricted to 100 tons. There was, however, some difficulty in obtaining good a foundation for the slip, which may have rendered it desirable not to impose an excessive weight upon it.

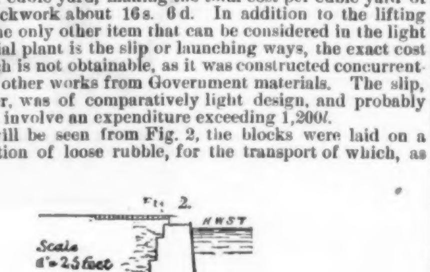
With reference to the cost of the work, we are indebted to the courtesy of M. A. De Miniac, engineer of the Arrondisement of Brest, for the following information:

The cost of the float, with its accessories for lifting and setting the blocks, amounted to 2,350*l.*, but the float was constructed so as to be also used for the transport of stone and other materials, and was, as before mentioned, of much greater lifting capacity than actually required.

The cost of the masonry of the blocks was 15 s. 8 d. per cubic yard, viz., materials, 10 s. per cubic yard; labor, 5 s. 8 d. per cubic yard, the last mentioned item including the cost and use of the platform or carriage on which the block was built. The expense attending the launching of each block amounted to 8 s., and the cost of lifting, transporting, and setting in place averaged 31 s. per block, or about 8 d. per cubic yard, making the total cost per cubic yard of the blockwork about 16 s. 6 d. In addition to the lifting float, the only other item that can be considered in the light of special plant is the slip or launching ways, the exact cost of which is not obtainable, as it was constructed concurrently with other works from Goverument materials. The slip, however, was of comparatively light design, and probably did not involve an expenditure exceeding 1,200*l.*

As will be seen from Fig. 2, the blocks were laid on a foundation of loose rubble, for the transport of which, as

Fig. 2.



well as of dredged material, the float used for lifting the blocks had been designed and used; the slip can also be subsequently employed for ordinary repairing purposes, so that in comparing the cost of the special plant with the cost of that used in other works of a similar character, only a portion of the gross cost of the float and slip should be included. If the total cost of the special plant be taken at 4,000*l.*, which is probably rather in excess of the actual cost, then at the end of five years' working, if interest at the rate of 5 per cent. per annum is added, and one-fourth of the cost of the special plant deducted—although in the particular instance under consideration, one-fourth of the first cost is hardly sufficient to represent the selling value of the plant—we find the amount chargeable for the use of special plant to be rather more than 9 d. per cubic yard of blockwork.

The system adopted at Brest possesses many advantages: the submergence of the block before lifting not only reduces the weight to be lifted from 100 tons to about 55 tons, but the position of the block during transit increases the normal stability of the float, enabling it to bear with safety the disturbing influence of waves; the block being suspended from the center instead of from the end of the float, prevents the necessity of a counterpoise, and thus the required displacement is reduced by one-half, the size of the float being proportionately diminished, which is a matter of great convenience, particularly when the works are carried on in a river or harbor much frequented by shipping. To these advantages must of course be added the great economy in the first cost of plant, and also the consideration that both the items of special plant, after the completion of the work, are but comparatively little diminished in value, inasmuch as they can be transferred to the necessary and permanent plant to be subsequently employed in works connected with the maintenance of the harbor, and other purposes.

Compared with the example first noticed, namely Aberdeen, the harbor of Brest lies in a much more sheltered position, and therefore presents less difficulty in the lifting and depositing of the blocks in the manner just described; but on the other hand blocks of double the weight might be used, and thus much greater advantage could be taken of the occurrence of calm weather, which in an exposed position is absolutely necessary if the blocks are to be floated into position. The tidal range at Brest is considerable, ordinary spring tides rising about 20 feet and neaps about 14 feet; this materially increases the facility with which the work can be carried on; a slight modification of the same system, however, renders it applicable to ports in comparatively tideless seas; for example at Fiume, on the northeast shore of the Adriatic, where the rise of tide is but slightly over 3 feet, a similar arrangement to that at Brest has been adopted.

The largest blocks in this instance measured 12 feet by 6 feet 6 inches by 5 feet, and weighed about 25 tons each; they consisted of about 10 parts by measure of Sautorin earth, four parts lime, and one part sand; the block yard was sufficiently large to contain about a thousand blocks, and they were allowed to harden for three months before use; they were transported on tramways worked with ropes driven by steam.

In launching, the block was allowed to run down a slip into the sea until its upper surface was slightly below the water; a raft was then floated over it, consisting of two boxes or floats connected at the top by a timber framework, and placed at such a distance apart as would allow the passage of the block between them; water having been admitted into the floats or chambers by suitable valves the raft was let down over the block which was then suspended by chains from the raft; the water being rapidly pumped out of the chambers, the block was lifted and the whole towed into position. Water being again admitted into the chambers of the raft, it was allowed to sink gradually and was guided into its place by a diver; the chains were then removed and the raft again rose to the surface. The work was designed by the French engineer, Pascal, and the blockwork, like that at Brest, is laid on a foundation mound of loose rubble or *pierre perdu*. The depth of the water varied between 29 feet in the old harbor, 72 feet at the end of the first mole, and 131 feet near the end of the breakwater. The level of the top of the rubble mound is not stated, but at Brest it is about 15 feet below low water of ordinary springs.

With reference to the blockwork at Brest, the following summary is given for convenience of comparison, the amount per cubic yard chargeable for special plant being computed after five years' and ten years' continuous working, respectively:

	£	s.	d.	
Quantity of blockwork deposited in place per year				21,240 cubic yards.
Approximate cost of special plant	4,000	0	0	
Cost of blocks—materials	0	10	0	per cubic yard.
" " labor	0	5	8	"
Launching, transporting, and setting of blocks (including maintenance of slip and float)	0	0	10	"
Proportion of cost of special plant at end of five years	0	0	9	"
Proportion of cost of special plant at end of ten years	0	0	5½	"
Total cost if work was continued 10 years (exclusive of cost of leveling foundations)	0	17	0	"

It will be more convenient to reserve for the present any remarks on the relative merits of different sections of breakwaters and quay walls, but it should be observed that the leveling of the top of the mound so as to form a suitable foundation for the blocks is a very important item in the cost of structure.

In the case of Brest, the preparation by divers for the reception of the bottom blocks would amount to about £8 for each block, and add (where two tiers of blocks were used) about 1 s. 6d. per cubic yard to the cost, making the total cost of the finished blockwork about 18 s. 6d. per cubic yard.

The simplicity and economy of the arrangements adopted at Brest, and the rapidity with which the work can be executed, highly commend the system, and in few others has the cost of special plant been so extremely moderate.—*Engineering.*

NEW ICE BREAKING VESSEL.

THE new icebreaker which the city of Gothenburg has had built, in order to keep the harbor open in the winter, has already rendered excellent service. Her construction deserves special notice. This vessel, which is the first of its kind constructed in Sweden, was built by the Lindholmen Mekaniska Verkstad, near Gothenburg. Her dimensions are: Length over all, 135 feet; greatest width, 35 feet; depth in the hold, under deck, 19¼ feet; while she draws aft, when loaded and with coals, for twenty-four hours, 12¼ feet of water. The vessel's keel, stem, rudder, and rudderpart are of best Swedish iron; but spants and knees are of Bessemer steel, containing 0·15 to 0·20 per cent. of carbon; all made at Motala. At her trial, the vessel attained a continuous speed of six knots per hour, and broke with the greatest ease ice from 5 to 6 inches in thickness, and in firm ice from 8 to 9 inches thick, in many places having accumulated in layers up to 15 inches. The vessel is provided with a series of iron tanks, which may be filled and emptied as required, in order to give her the trim and draught demanded by the various thicknesses of the ice. She has steering apparatus both for steam and hand. These are found to work admirably. The cost of the vessel is £25,000.

THE ordinary stove-pipe is made of very smooth iron plate, glazed or highly polished. If it was specially designed for carrying the products of combustion up the chimney without their parting with any of their heat it would scarcely be made in a manner that would suit the purpose better.

IRRIGATION IN NORTHEASTERN COLORADO.

By Mr. P. O'MEARA, M.Inst.C.E.*

THE objects of the paper were stated to be three-fold: First, to give an account of the development of irrigation in Northeastern Colorado; secondly, to inquire into the principles which should guide the introduction of irrigation into new countries; and thirdly, to examine how far the methods being pursued in Northeastern Colorado were in accord with them. The development alluded to was influenced by most of the defects manifested in older countries, such as inaccurate measurement of water, growth of ill-defined rights, excessive waste of water, etc., but there was a prospect of improvement through better legislation. The climate of Colorado was described as such that agriculture was all but impossible without irrigation. Both were begun in 1860. There were 155,000 acres under cultivation in 1880, and it was estimated that in 1883 there would be 465,000 acres, with prospects of still further development. The amount of irrigation possible would be limited by the quantity of water obtainable, and by the area which each unit of it could be made to irrigate. It would amount to 9,750,000 acres under a hypothetical water duty of 12 in. in depth for one season.

It was laid down that the duty of water in irrigation must vary with (1) the character and condition of the soil; (2) the rainfall, temperature, and evaporation; (3) the method of application; (4) the kind of crop; and, in some cases, (5) the depth of the water-line below the surface of the ground. As regards (1) the influence of different soils, this must affect the duty of water, because, on the nature of the soil depended the quantity of water it should absorb, and the rate of filtration and of evaporation from within it. The author gave details of experiments made by him to ascertain the amounts of water, and the times required to moisten two different typical soils in the Cache la Poudre Valley, and he drew some inferences from them. The formation of swampy lands and the prevalence of rust in wheat on some of the older farms were held to indicate that the quantity of water required for beneficial irrigation became gradually less year by year for a few years after the commencement. (2) The rainfall of the season should be added to the artificial irrigation, and account should be taken of the surplus water not absorbed by the soil, otherwise all estimates of water duty must be misleading. The use of ordinary statistics of temperature and evaporation was at present vague and unsatisfactory, owing to the absence of experiments on the drying of soils. Nevertheless, the question of evaporation was so important that it was doubtful if any loss of irrigating power occurred in Colorado other than that which was due to it. (3) Irrigation methods were conducted on two antagonistic principles, viz., to increase to the most profitable extent, in the one case, the quantity of water supplied to a given area, and in the other the area irrigated by a given volume of water. The "Marcite" cultivation of Italy and the "asbestine sub-irrigation method" of California were cited as instances of these. Methods of irrigation were classed under four heads: by sprinkling, by flooding, by distributing through furrows, and by distributing through pipes or drains underground. Sprinkling had been tried in Scotland on seven acres of land by the Duke of Sutherland. The methods of flooding with compartments, and of distributing through furrows, were described in detail, as also the method of flooding without compartments, as practiced in Colorado. This was characterized as extremely wasteful. It was shown from the experiments on dry soil, before alluded to, that 6 in. or 8 in. in depth, instead of 42·84 in. as at present extended, ought to suffice for cereals in Colorado. The experience of Professor Blount, of the State Agricultural College, was quoted to show that excellent crops of wheat could be grown with a rainfall of 4½ in. only without irrigation. As regards (4) the water duty for different crops, it was the degree of moisture required in the soil around its roots, and not the absolute quantity which the plant itself absorbed, that had to be considered.

The author furnished, in a tabular form, a list of statistics, derived from various sources, in which he had endeavored to include the essential elements. He considered it, however, to be nothing more than an approximation, because of the incompleteness of almost every statement of the kind. In the column of "totals" the limits of water duty appeared much narrower, because of the rainfall being added to the irrigation depth, than they would be otherwise. Countries where good crops were grown without irrigation were included in the table, being considered to furnish a "natural duty of water," which should be useful for comparison with water duties in places where irrigation was practised. Some remarks followed with respect to the peculiarities of certain crops, viz., rice, alfalga, sugar-cane, summer meadows, potatoes, cereals, and tea.

The author then discussed the sources and works of supply, and the legislation of irrigation. The sources were stated to be two, viz., springs and rivers. The supplies were made available for direct irrigation by canals, and for indirect irrigation, after storage, by reservoirs. The works of the North Poudre Irrigation Canal, of a capacity of about 300 cubic feet per second, which had been carried out under the author's charge, were described. Those most worthy of remark were a crib dam, 30 ft. 6 in. high, some shelf work, tunnels, and "gulch" bridges. Details were also given of a larger canal, the Northern Colorado.

These works showed a considerable departure from the practice of older countries, owing to the abundance of timber, and to the preference of Americans for economy and rapidity in construction over durability. The principal supplies of water in Colorado came from the snows of the Rocky Mountains. The rivers rose, reached their maximum, and fell again, frequently before the end of the irrigation season. Hence measurements of the snow remaining on the mountains were of importance to agriculturists. The construction of reservoirs was dealt with as a means of reducing risk in cultivation in countries where the rivers failed in the crop season. Reservoirs were distinguished as of three kinds: "River-bed" reservoirs for equalizing the flow, "main" reservoirs which received the entire volume of a canal, and "detached" reservoirs which received a portion only. A serious error in the construction of some reservoirs in Colorado was pointed out.

The gauge first used for measuring water in Colorado was the Max Clark gauge, and the improved system at present in use, with the formula of Francis: $Q = 3{\cdot}33\,(l - 0{\cdot}1\,n\,h)\,h^{\frac{3}{2}}$, were described and commented on. A short account of the legislation affecting irrigation in Colorado followed. The legal definition of an "inch of water" was given in full. Those laws were such that any holder of land in the State was entitled to take and use the waters of the rivers, and any one could construct reservoirs and store unappropriated water. A fruitful crop of litigation had, as a matter of course, been developed in the State; and some cases were still pending. A series of laws were passed in 1879 to determine the order and priority of existing and future claims, to fix the price of water, and to control its distribution.

The author finally directed attention to the report of the State Engineer of California on similar laws, concurring generally with the principles advocated therein, and suggesting a free exchange of water rights, and the condemnation of such reservoir sites as were used for direct irrigation only.

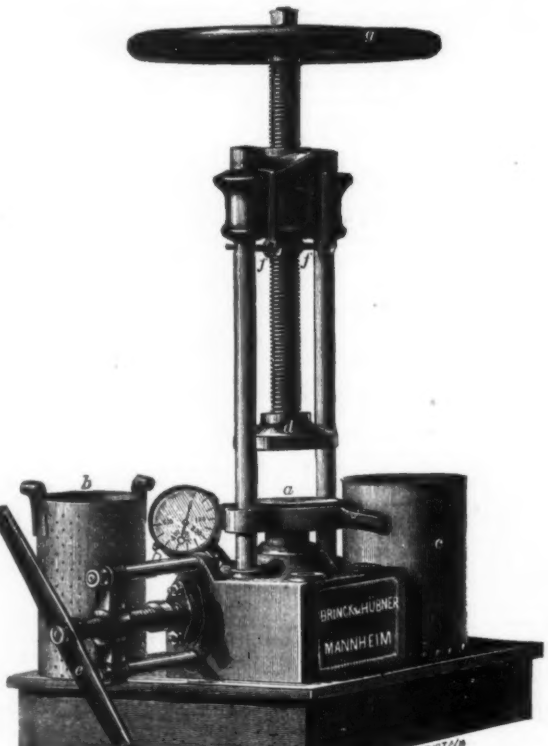
* Abstract from a paper lately read before the Institution of Civil Engineers, London.

BRINCK & HUBNER'S HYDRAULIC PRESS.

SUCH hydraulic presses as are in use in the industries are, for the most part, set in action by means of plunger pumps, thus greatly increasing the first cost of the plant. Large manufactories are easily able to bear this increase in expense, owing to the possibility of their making several presses in succession by means of a single pump, the piping of which is arranged for that purpose; but it is not so with regard to small shops, for in these it costs considerable to install apparatus of the ordinary system.

The type of press shown in the accompanying cut has been devised by Messrs. Brinck & Hubner with a view to meeting the wants of these last-mentioned establishments. The smaller sizes are adapted for use in laboratories and can be actuated by hand with a single maneuver. The larger sizes are designed for manufactories of chemical products, sirups, oils, etc., and, in general, for all operations that are performed at high pressure. Neither size requires the use of suction and force pumps, but employs, instead, a simple screw plunger whose operation is surer and more regular.

The construction of these presses may be readily understood by a reference to the lettering in the engraving. In the first place, the base of the apparatus supports two cylinders, which are filled with glycerine and communicate with each other by means of an internal conduit. Each of them carries a tight piston, one having a vertical and the other a horizontal direction. The first, which is designated by the letter *a*, is cast in a piece with a circular disk on which is placed a perforated steel plate cylinder that receives the material to be pressed, this latter being separated into layers by disks. This perforated cylinder is placed within a metal jacket, *c*, which is designed to prevent the juice from spurting beyond the rim of the collecting reservoir beneath. After filling the cylinder and putting it in place, the material is submitted to pressure by revolving the hand-wheel, *g*, which is keyed at the extremity of a vertical screw whose nut is held by the head of the frame. It follows that the piece, *d*, will exert a sufficient pressure to produce a large amount of juice. As soon as the resistance becomes too great the workman ceases to revolve the hand-wheel, and turns the winch, *e*. This latter terminates in a plunger, which enters the cylinder filled with glycerine and gives rise to a pressure equal to 300 atmospheres. To take out the cake at the end of the operation, the perforated cylinder, *b*, is suspended from the head of the press by means of the straps, *ff*, and the hand wheel is revolved so as to cause the descent of the screw, and, along within it, the inclosed mass of pressed material.



BRINCK & HUBNER'S HYDRAULIC PRESS.

In operating with substances that contain much liquid, and that are consequently easily compressed, it often happens that the necessary pressure has not been attained after the penetration of the smaller cylinder. In such a case it becomes necessary to unscrew the latter, exert a pressure again with the upper hand wheels, and then drive in the hydraulic piston anew until the pressure gauge denotes 300 atmospheres.

After using them for a certain length of time, if the cylinders require a fresh supply of glycerine, the pressure-gauge is unscrewed so as to permit the remaining fluid to flow out through the orifice thus opened, and then, after screwing the vertical piston all the way down, the horizontal one is withdrawn entirely. It then only remains to pour in the glycerine slowly, so as to allow the air to escape, and to put the pressure-gauge back in its position.

With a view of expediting the operation, the manufacturers have got up for large establishments a form of press with two differential pistons. In these apparatus, when the larger of these pistons does not bring about a sufficiently high pressure, the other one is at once actuated without its being necessary to draw back the former and to actuate the vertical screw. These two pistons are actuated by a single winch which acts upon a pair of gearings, and are capable of working simultaneously or successively.

These presses of Messrs. Brinck & Hubner are equally well adapted for use in operations of some importance, and are, in such cases, provided with belt-pulleys, endless screws, and friction-disks for actuating the pistons, and with an apparatus for lifting the perforated disk and expelling the cake therefrom. The manufacturers are also constructing presses on the same principle for testing the strength of building materials.—*Revue Industrielle.*

ON SOME APPARATUS FOR USE IN CONNECTION WITH ELECTRIC LIGHT MEASUREMENT.*

By ROBERT SABINE, C.E.

HAVING occasionally to make measurements requiring some degree of exactness of the electric and photometric values of electric light systems, in reference to the power expended in maintaining them, I had for some time difficulty in finding apparatus specially adapted for this work, the electrical instruments which were suitable for continuous current systems being, as a rule, unsuitable for alternate currents. I was, therefore, induced to design some apparatus for my own use, which I have found convenient and sufficiently exact for practical purposes.

I. THE PHOTOMETER.

The absorption of light when passing through translucent media has hitherto been almost entirely unemployed for photometric purposes. Lampadius, it is true, suggested the reduction of any ordinary light to its vanishing point by means of thin sheets of horn, assuming that this vanishing point might be taken as a fixed unit of intensity—a method which De Limency and Secretan proposed to modify by employing sheets of paper instead of horn—and Count Xavier de Maistre and Quetelet suggested the employment of wedges of blue glass for purposes of stellar photometry. But in neither instance was anything approaching to a practical photometer produced.

The photometer which I am about to describe is based upon the partial equalization of any two lights under comparison, by interposing in the path of the rays of each light a sufficient thickness of absorbing material, the final adjustment being made by a slight alteration of the relative distances of the lights from the photometer.

Instead of comparing the lights directly with each other, I find that much better results are obtained by comparing them singly with a third light, which is constant.

This constant light I obtain by allowing the rays from a small portion of the bright part of a paraffin flame to pass through suitable diaphragms; the advantage of this method being that so long as the diaphragms are not too large, any trifling irregularity in the paraffin flame, through burning higher or lower, does not affect the small portion of the bright part which is employed, and, therefore, the utilized light is practically as nearly constant as possible. The form of apparatus which I use is shown in section in Fig. 1, in which the photometer is placed, for convenience of illustration, vertically, as if measuring a light immediately above it. The graduated scale, *a*, *a*¹, upon which the photometer travels, turns upon a center carried by a stand (not shown in the drawing), and can be elevated or depressed to any desired angle. The photometer consists of a square brass box, *d*, *d*, on one side of which is a draw tube, and eye-piece with lens, *g*, and on the other side a tube, *f*, carrying a collar by which the paraffin lamp, *b*, *b*, is supported, and may be kept in a vertical position at whatever angle the scale may be directed. The chimney of the paraffin lamp is of copper, and opposite to the bright part of the flame is pro-

* Paper read before the British Association meeting, Southampton, 1882.

vided with a tube, c, in which are a thin pane of glass and two diaphragms, and at the back another tube, c^1, in which a dark glass is fitted for observing, from time to time, the flame, to ascertain that it is burning in the proper position.

At p_1 is a thin sheet of translucent material, part of its inner surface being observed by the eye at g.

The light to be measured is placed at a distance (under three feet if possible) beyond the end, a, of the scale, so that its rays fall upon the face of a thickness of translucent material, p, inserted in a suitable guide at the side of the photometer, its inner surface being observed by the eye at g, reflected by the prism, e, which occupies half of the field of view. The thickness of the interposed translucent material, p, is adjusted until the illuminations of the two halves of the field of view are as nearly equal as this adjustment allows; then the distance between the light to be measured and the face of p is adjusted by causing the photometer, which is mounted on rollers, to travel on the scale until the two halves of the field of view are equally illuminated.

The illustration shows the photometer directed vertically upward; but as the lamp may be turned with the collar which supports it, the scale may be placed horizontally or inclined at any desired angle upward or downward. In order to lessen the effect upon the eye of slight differences of color between the lights to be compared, there are inserted just at the top and bottom of the line in which the two halves of the field of view meet, small strips of highly colored glass. The effect of the presence of these, when I am observing, is to render the eye partly unconscious of small differences of tint of the middle portions of the field of view, without reducing its sensitiveness for appreciating the balance of illuminating effect.

The comparison with the horizontal light of a standard candle is done by placing the photometer horizontally and putting the candle at the end, a, of the scale, reducing at the same time the thickness of the translucent material, p, until a balance is nearly obtained, and finally adjusting by sliding the photometer along the scale.

The intensity of the light which penetrates from the paraffin lamp to the inner surface of the translucent sheet, p_1, and which is the constant of comparison, we will call λ. We may assume that of the light which falls upon the surface, p, the fraction which is scattered and reflected bears to it a constant relation, r.

Let L be the illuminating power of the measured light in the direction of the photometer, n the thickness of absorbing material, and D the distance of the source of light from p. Then the light which reaches the surface of p, when a balance is obtained, will be:

$$\lambda = \frac{(-r)\,\mathrm{L}\,m^{n}}{\mathrm{D}^2},$$

m being the co-efficient of translucency of the absorbent body, p; that is to say, the intensity of light which succeeds in reaching the inner surface of a unit thickness of p, when a unit intensity of light enters the outer surface.

Similarly, for the standard candle, the illuminating power of which is l, its distance d, and the interposed thickness of the same translucent material n_1:

$$\gamma = \frac{(1-r)\,l\,m^{n1}}{d^2},$$

the relation of these two lights is therefore:

$$\frac{\mathrm{L}}{l} = \left(\frac{\mathrm{D}}{d}\right)^2 m^{n1-n}$$

it being assumed that the light of the paraffin lamp has remained constant during the two observations, and that the atmosphere has not acted as an absorbent.

The co-efficient of translucency of the interposed absorbent material must, of course, be very carefully determined, because upon the value of this co-efficient being exactly known depends the accuracy of the results obtained as much as upon the accuracy of the final adjustment of distance.

This co-efficient I determine by employing a strong steady light, and taking observations of distance first with one, then several (say, n) thicknesses of the material.

If the observed distance with one thickness is d_1, and that with n thicknesses is d_n;

$$m = \left(\frac{d_n}{d_1}\right)^{\frac{2}{n-1}}.$$

I find that the readiest way is to take alternately the distances with one and three thicknesses, because then

$$m = \frac{d_3}{d_1},$$

a simple relation which saves calculation.

The comparison of one with two thicknesses was found to be objectionable, as any error of observation was exaggerated, whereas when more than three were taken for the co-efficient the illumination of the field became weakened, and the observations were less accurate.

It is not necessary that the translucent body at p_1 should be either of the same quality, tint, or thickness as that used at p, as it is simply intended to provide a constantly illuminated surface for comparison; but the thickness of the material used at p must be carefully selected, and must be as uniform as the eye is capable of detecting. The material which I have found to be most convenient for use as an absorbent consists of thin plain photographic paper, which is very uniform in texture, and is easily procurable.

In the earlier form of this photometer, the comparison was made direct with a standard candle, by inclosing the latter in a candle-holder consisting of a closely-fitting tube, furnished with a spring, which pressed the candle up against a top rim, and maintained it at a constant level in a suitable dark lantern.

It was found, however, that a candle so circumstanced always gave a reduced light, and that other lights compared with it appeared to be exaggerated in photometric value; moreover, the difference of color between the light of a candle and that of most electric arc lamps is very striking, while the color of a paraffin flame is between the two, and the difference, therefore, between it and either the candle or electric light is less embarrassing.

When it is desired to employ Schwendler's method of observing the illuminated surfaces through colored glasses, I place them before the eye-piece, g.

II.—THE CURRENT DYNAMOMETER.

The current dynamometer is constructed to be equally applicable to continuous and alternate currents.

It consists of two circular flat coils of thick copper, a and b, as shown in outline in Fig. 2.

One of the coils, a, is carried on a beam, together with a counterweight, by a bifilar suspension. This suspension is done by a thin silk thread, the two ends of which are fixed to a torsion-head at d, its middle portion passing under a small friction pulley, p, attached to the beam. By this means the strain upon both sides of the bifilar thread is equal. The ends of the movable coil, a, are amalgamated and dip into two suitable mercury cups (1 and 2). In the position of rest, the torsion-head of the bifilar suspension is turned so that the plan of the coil, a, forms an angle of 5° to 10° with the plane of the coil, b; its angular position being observed by a mirror attached to the suspended coil, which projects a spot of light upon a scale placed at a constant distance. The second flat coil, b, is mounted upon grooved copper feet, which slide upon two copper rails, c, c^1, keeping coil, b, at right angles to the rails and facing coil, a, but at distances which may be readily varied.

The dynamometer is inserted in the circuit whose current is to be measured, between terminals connected with the points 1 and 3. The current from M enters the system at the terminal connected with the mercury cup (1), circulates (right-handed) through the suspended coil, a, which it leaves

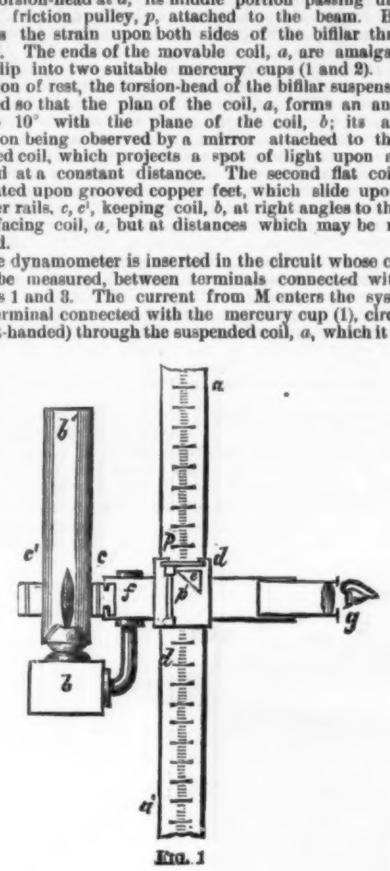


FIG. 1

by the mercury cup (2), passes along the rail, c^1, to the sliding coil, b, in which it circulates (left-handed) passes to the rail, c, and so back to the circuit.

The repulsion which takes place between the coils results, of course, in the deflection of the suspended coil to a greater or less degree, according to the strength of the current and the distance between the coils. If this deflection is insufficient to place the coil, a, parallel to coil b, the latter is slid along the rails nearer to a, but if the repulsion cause a to be deflected beyond its parallel position, coil b is drawn back until the light point settles to the zero of the scale.

The sluggishness of the mercury in the cups is utilized to check any continued oscillation.

The scale of the instrument is placed between the rails. It was calibrated by comparison with a tangent galvanometer, the position of the sliding coil, b, when the parallel position of the suspended coil was obtained being marked for each ampere of current; and it was found that beyond one ampere the distance was practically proportional to the current, but below one ampere this proportion did not obtain, probably due to want of symmetry in the coils themselves.

As the deflection of the suspended coil is always the same, the repelling force acting upon it is constant; and if this

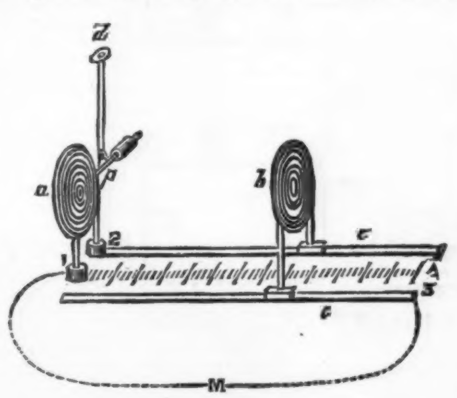


FIG. 2.

force is directly proportional to the square of the current, and inversely to the square of the distance between the coils, it would follow that the current and distance should be directly proportional to each other.

The resistance to deflection of the suspended coil must, of course, be kept as constant as possible. This I have attempted by using unspun silk for the bifilar suspension, and putting the threads at a sufficient distance apart to cause the resistance to deflection to be due more to the lifting of the coil than to the torsion proper of the threads.

By making the current go through the two coils in derived circuit instead of in series, the sensitiveness becomes reduced to half; the range of the scale being proportionately increased. For very strong currents the range of the scale can be increased to any extent by properly arranged shunts.

When measuring very strong currents, the disturbing effect of the earth's magnetism has to be considered. In order to allow for this, before making an observation I place a coil of wire of the same resistance as one of the working coils, but double wound, upon the rails in place of b. This dummy coil has no deflecting effect upon the suspended coil, but renders the current moving through it the same as when b is in its place. When this is done the effect of the earth's magnetism is to cause a slight deflection of the suspended coil from its position of rest, to which it is then readjusted by turning the torsion head.

So far I have found this method to be convenient. Although the apparatus I use is home made, it has the advantage of being strictly a zero method, and the instrument is not encumbered with any table for the reduction of observations.

III.—THE POTENTIAL DYNAMOMETER AND RESISTANCE MEASURER COMBINED.

This instrument is designed to fulfill a double duty, and as a potential dynamometer is equally available for continuous and for alternate currents.

It consists of two circular coils of moderately fine copper wire, one of which is held by a bifilar wire suspension inside the other, as in Weber's well known dynamometer. When required, however, to be used as a galvanometer, the suspended coil can be readily removed and replaced by a magnet needle.

When used as a dynamometer with a potential difference of one Daniell between the terminals, the suspended coil is deflected to between 100 and 150 divisions of a reflected light point falling upon a scale at a distance of 100 centimeters. This reading, which remains very constant, can, however, be adjusted for a greater or less degree of sensitiveness by altering the distance apart of the bifilar suspending wires.

The reading with one Daniell potential difference is the constant of the dynamometer, and is obtained by inserting between the terminals a Daniell cell having a resistance sufficiently small that it may be neglected without appreciable error.

When any greater potential difference is to be measured, an adjustable resistance is inserted in the circuit in order to reduce the current (and deflection) to the same value as the constant. For instance, if a potential difference, x, of an electric arc is to be measured, the terminals of the lamp, or connections from the carbons, are inserted, with an adjustable resistance which is gradually reduced to r, so as to reproduce the constant deflection of the light point. The constant current is then represented by two equations:

$$\mathrm{C} = \frac{e}{\rho},$$

ρ being the resistance of the dynamometer wires, and e, volts, the electromotive force of the Daniell, and

$$\mathrm{C} = \frac{x}{r+\rho},$$

assuming that the resistance of the arc may be neglected, as it is very small in comparison with $r+\rho$.

The electromotive force of the arc is therefore:

$$x = e\left(\frac{r}{\rho}+1\right)\text{volts.}$$

The effect of the earth's magnetism upon the suspended coil is, of course, entirely eliminated, the current being the same in each observation.

The resistance box which I use in connection with this dynamometer is constructed with adjustable resistances between 1 and 100,000 ohms, and has in addition the usual proportion coils of a Wheatstone bridge.

When it is required to measure the wire resistance of a circuit, this resistance box is employed as a Wheatstone bridge. The suspended coil of the dynamometer is removed and a magnet needle inserted in the center of the stationary coil, so as to readily provide a galvanometer which is sufficiently sensitive for measuring small resistances with the aid of the constant Daniell cell, thus avoiding the necessity of providing separate instruments for this purpose.

IV.—THE MEAN PRESSURE INDICATOR.

The determination of the horse power performed by the steam engine is usually made by taking diagrams with a Richard modification of Watt's indicator. There are, however, some objections to the use of this instrument for this purpose, arising from the necessity of special fittings, besides the fact that these diagrams, obtained at considerable trouble, give more information than is wanted for the object in view.

The horse power is calculated only from the mean pressure, which I have endeavored to arrive at in a more simple way. Instead of taking indicator diagrams, I have obtained very good results with a simple Bourdon pressure gauge, so arranged that the mean pressure at either end of the cylinder can be read off at once, and the horse power obtained at any moment with very little trouble.

For this purpose I attach to each end of the cylinder a pressure gauge, the pipe leading to which is throttled sufficiently to allow only of a small entry and exit of steam at each stroke. This throttling may be carried to such an extent that the pointer of the gauge rises comparatively slowly to the mean pressure, above and below which it makes small oscillations.

In the arrangement of the gauge, the attachment to the blow-off cock of the cylinder is conveniently made by a short length of thick India-rubber tubing, strengthened by a double serving of tape and lashed. Between this and the gauge I insert a tube of brass containing, in a socket coupling, a screw plug, through which a small hole is bored. Every precaution has, of course, to be taken to prevent condensation of steam in the throttle or in its immediate neighborhood. For this purpose I keep the throttle tube at a temperature considerably above the temperature of the steam by placing the flame of a lamp underneath it. Between the throttle and the pressure gauge is a small blow-off cock. Before observing the mean pressure, this cock is opened and steam blown through. It is then closed and the pointer of the gauge rises by a series of jerks up to the mean pressure, about which it oscillates through a small arc, the mean point being easily observed.

STORAGE BATTERIES.

PROF. HENRY MORTON recently read a paper on the storage of electricity to the members of the New York Electrical Society, at the Stevens Institute of Technology, in Hoboken. Edison incandescent lamps lighted the room, a two-horse power Weston electric motor stood on the lecture table, and the lamps and motor were furnished with electricity from the Sellon-Volckmar accumulators.

Professor Morton briefly described the principles involved in the present methods of electrical storage. He then explained the structure of the Sellon-Volckmar battery, which consists of plates, each made of a fine lattice work of metallic lead, filled in with a porous mass, which was in each alternate plate either metallic lead or the black peroxide of lead. The experiments made by the lecturer showed that each cell in

the battery would yield a continuous current or about thirty-two amperes for nine hours, with an electro-motive force of about two and two-tenths volts, a quantity of current sufficient to supply forty-four of the Edison incandescent lamps of 16 candle power, without employing more than 50 of the cells to secure sufficient electro-motive force to overcome the resistance of the lamps. Each cell weighed only 80 pounds when ready for work, so that for each light of 16 candles, burning one hour, 10 pounds of battery should be provided, if it were used solely as a reservoir to contain the current required.

Experiments with the lights in the room were made to show that the battery in many cases would only be required to act as a regulator, simply taking up a temporary excess of the entire amount of electricity used, and providing for a temporary deficiency. By connecting the lights directly with a dynamo, its current was made to fluctuate, so that the lights flashed up or faded according as the current was strong or weak. By connecting the dynamo with the battery, so that any excess of current could flow into it, or any deficiency be supplied by it, the lights burned perfectly steady.

Touching on the question of using the storage batteries as a means of driving street cars, Professor Morton said that his measurements showed that each battery of 80 pounds weight contained energy equal to about 1,800,000 foot-pounds, or sufficient to take a one-horse car full of passengers across town, or from one end of the city to the other.

THE GAULARD-GIBBS SECONDARY GENERATOR.

Fig. 1 represents a perspective view of the secondary generator, Fig. 2 a vertical section of one of the columns, Fig. 3 a section of the conducting and generating cable, while Fig. 4 is a diagram showing the method of distribution. It will be seen that the apparatus is composed of four vertical columns, each having a hollow cylinder, upon which is rolled a cable composed of a central copper wire of four millimeters diameter, forming the inductor through which, by means of a commutator placed on the lower platform (Fig. 1), the primary current is passed in one, two, three, or four columns. Parallel to the axis of this central wire, and completely surrounding it, are 72 copper wires, half a millimeter in diameter, and individually insulated with paraffined cotton; these form the secondary wires; by a handle on the upper platform they may be grouped in quantity or in tension. The extremities of the fine wires of each column are attached to eight terminals on the upper platform, by which means they can be employed separately or grouped in tension or in quantity. The movable cores of soft iron may be raised or lowered by means of handles placed at the side of the apparatus, thus allowing the regulation of the energy of the current developed in the secondary wires, and consequently enabling the variation of the intensity of the current from 0 to its maximum.

Two secondary generators placed on the same primary circuit are shown at the Aquarium; the primary current is furnished by a Siemens alternating current dynamo, the quantity of the current being 18 amperes. One of the machines, having its four columns grouped in quantity, furnishes a current of 40 amperes, feeding 26 incandescent lamps distributed about the court. The other secondary generator, from two of its columns grouped in tension, lights a Jablochkoff candle at the same time that the two other columns, grouped in quantity, furnish currents, the one for five Swan lamps, and the other for a motor. The terminals where the primary circuit is joined to each apparatus may be touched without the slightest perceptible effect.

It is pretty well established that the general and practical employment of electricity is dependent upon the following conditions: First, the economical mechanical production of electric currents, which, wherever possible, should be produced by utilizing natural forces. Secondly, the distribution over great distances, not of an electrical current, but of electrical energy, which is a very different matter, for every given current has special properties, and consumers should not be limited to the employment of special apparatus adapted to the given current, for this would be to discourage improvements in such apparatus. Thirdly, the distribution of electrical energy must be effected without permanent danger to consumers, and as far as possible to an unlimited extent. Lastly, the consumer should be able to transform this electrical energy into currents of every kind, and consequently adapted to every purpose already known or that may hereafter be discovered, among the former being lighting by incandescence and by arc, voltaic, chemical processes, such as electro-plating, and furnishing motive power.

All these numerous conditions appear to be fulfilled by the secondary generators of Messrs. Gaulard & Gibbs. In practice one of these apparatus would be placed in each house, all of them on the same circuit, traversed by an alternating current of small quantity and of sufficient tension to overcome the sum of the resistance offered by the electro-motive force generated by each machine. The length of this circuit is unlimited, which enables the fulfillment of the first condition, that is to say, the working of the generating dynamo machine by hydraulic power. This circuit is of small diameter because it is traversed by a current of small quantity (15 amperes), and since it is metallically closed without the possibility of being open in any part, it may be traversed by currents of the highest tension without in any case being dangerous in the event of its coming in contact with the human body. This fulfills the second and third conditions. Lastly, under the influence of the movement of the primary current which traverses all the secondary generators, electrical currents of quantity and of varying potential—according to the manner in which the secondary wires are grouped by the consumer, who can vary them at will by means of a commutator—are gathered on the different columns composing the apparatus and consequently permitting their application to every purpose such as incandescent and arc lighting and the production of motive power, thus fulfilling the fourth condition.

All these things having been practically demonstrated, we are justified in saying that, so far as present experience shows, the secondary generators of Messrs. Gaulard & Gibbs fulfil all the conditions necessary for the solution of the problem of the distribution of electrical energy. Since their apparatus is the only one capable of being placed in a metallically closed circuit, they alone at present are able practically to utilize and distribute natural forces. They are entitled to every credit for having conceived and carried out a system which is an ingenious and a distinct departure from the beaten track, and which marks an era in the practical application of electrical science.—*Iron.*

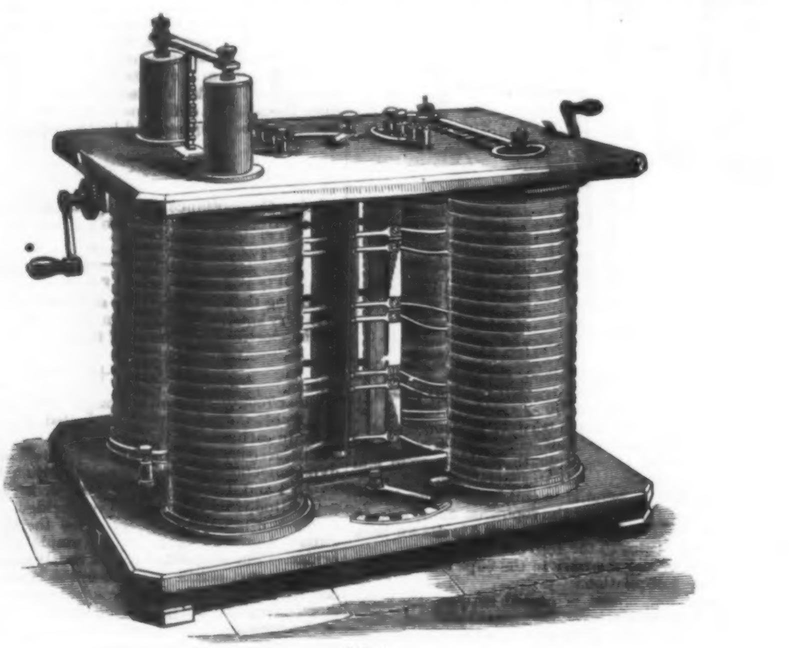


FIG. 1.

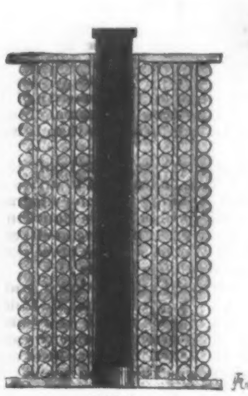


FIG. 2.

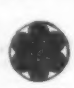


FIG. 3.

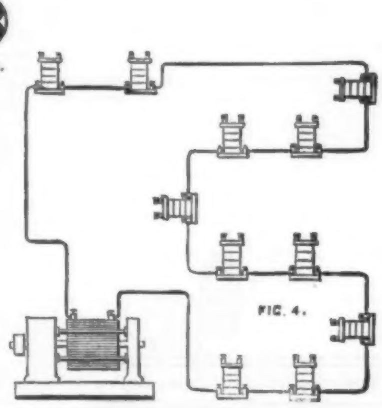


FIG. 4.

THE GAULARD-GIBBS SECONDARY GENERATOR.

POLLARD'S TELEPHONE.

For the last two years Mr. Charpentier has been constructing, according to instructions furnished by Mr. Pollard, some magnetic telephones whose arrangements and mode of regulation are worthy of note.

In the annexed figure the upper part alone is shown in section.

A is a very powerful horseshoe magnet, made of from 2 to 3 pieces according to the dimensions of the instrument. These pieces are separated from one another, in the middle and at the extremities, by soft iron wedges. To the two outer ones is riveted the piece that carries the eye, *m*, by means of which the telephone is suspended, and to the middle one are screwed the soft iron polar appendages, *f f*, which serve as cover to two flat bobbins placed opposite each other as in the Siemens, Gower, and Ader telephones.

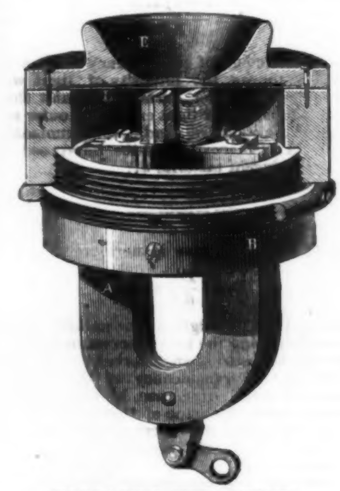
The two branches of the magnet enter a cylindrical block of wood, B, in which they are firmly held by the tightening up of a brass cross-piece by means of a screw, V, in the interior. The instrument is capable of being taken apart and put together very easily.

The vibrating plate, L, of tin, is held by a box, likewise of wood, which is movable and made in two parts. One of these latter, C, is screwed to the block, B, and the other, E, is fixed to the former by wooden screws and serves as a mouth piece.

Regulation is effected by revolving the movable box with the hand and consequently screwing it on to the fixed block. A metallic threaded ring, *a*, plays the role of a set screw and permits of fixing accurately the position of the vibrating plate after regulation. Under these circumstances the regulating is easily performed and is very precise, and, on another hand, an inspection of the instrument may be made immediately by unscrewing the movable box.

In the large size the vibrating plate is from four to five-tenths of a millimeter in thickness, and about 7 centimeters in free diameter. The bobbins are of fine wire (No. 40) and possess, together, a resistance of 300 to 400 ohms. The wires are attached by means of bolts traversing the fixed block and having pliable cords connected with their extremities.

In a smaller size the vibrating plate is only 6 centimeters in diameter and a third of a millimeter in thickness; and the magnets, which are smaller, are made of two pieces only.



POLLARD'S TELEPHONE.

The large size constitutes an energetic transmitter and receiver. It is less sonorous, less noisy than the Siemens apparatus, but it is intense and remarkably clear. It has been advantageously employed as the sole apparatus in several of the telephone stations of the naval arsenals, and is destined to render services in laboratories as an apparatus for study and demonstration.

This telephone is capable of furnishing a direct call in the following way: By regulating the plate so as to be very near the poles of the magnet, and by endeavoring to make it vibrate after the manner of a Reuss transmitter. The succession of the shocks of the membrane against the polar appendages will give rise to intense currents, which will be denoted by the receivers giving out a musical sound that may be heard at a distance. The intensity of this call may be increased by arranging between the bobbins a small tube containing a brass rod that is capable of moving freely in the interior.

When the telephone is held in the hand for listening or speaking, the small mass of metal rests naturally at the bottom of the tube at the side of the block of wood, and proves no obstacle to the working of the instrument. At rest, the telephone being suspended by the eye, *m*, and its mouth piece pointing downward, the metal then falls, and, while still remaining in the tube, rests upon the center of the membrane.

The regulation of the apparatus is performed, as in all magnetic telephones, with great accuracy by endeavoring to get the plate as near as possible to the magnet, without, however, having it beat against the polar extremities.—*La Lumière Electrique.*

ON THE RE-ENFORCEMENT OF SOUNDS TRANSMITTED BY THE TELEPHONE AND MICROPHONE.

The Russian journal *Electricite* published under this heading, in its No. 16 of the present year, an article by Mr. Woukouloff, from which we extract the following:

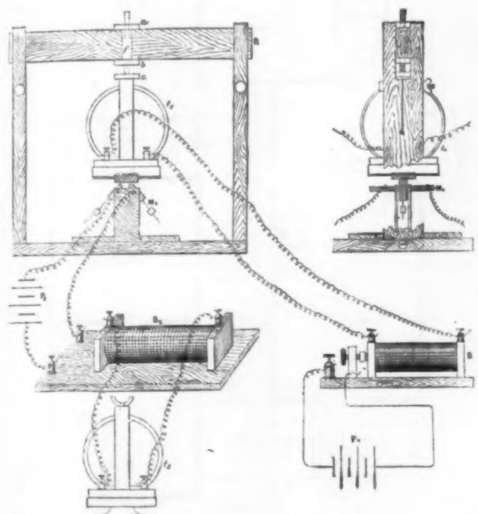
"Prof. Tarchanoff has engaged me to devote my attention to the application of the microphone and telephone to the re-enforcement of the feeble sounds of a *muscular* current. On causing such a current to pass into a telephone and interrupting it, we obtain a very feeble sound. I have succeeded in re-enforcing this considerably by the following system: To the iron plate of the telephone through which the muscular current was passing a microphone was adapted. This latter was of the Wreden type, which is lighter

and more easily regulated than others. It made part of a circuit, which included, in addition, a pile and an induction bobbin, and the fine wire of the bobbin was connected with a second telephone. To the plate of this latter there was likewise fixed a microphone, included, in the same way, in the circuit of a pile and a bobbin. The induced wire of this bobbin was connected with a third telephone, and so on. I employed in these experiments only three telephone-microphones; the fourth, which was of the ordinary style, served for receiving the re-enforced sound, and was placed in a distant spot, separated by several rooms.

"The following are the results obtained with this apparatus:

"The muscular current that operated the first telephone set in motion, at the same time, the microphone that was adjusted to the telephone plate.

"If the microphone is properly regulated, there is always obtained a sound which is a *little stronger in the second telephone than it was in the first* The second microphone will re-enforce again the sound transmitted, and in the third it will be yet stronger, and so on. In my experiments, made by the aid of three telephone-microphones, the sound was so strong in the fourth telephone (provided with a speaking trumpet) that it could be heard very distinctly at a distance of several meters. On placing a watch upon the first microphone, I obtained in the last receiver a sound analogous to that of the drum."



ON THE RE-ENFORCEMENT OF SOUNDS TRANSMITTED BY THE TELEPHONE AND MICROPHONE.

Farther on, Mr. Woukouloff says: "I am unable to continue my experiments with regard to the application of this apparatus to the re-enforcement of *all* the sounds transmitted by the telephone and microphone, so I publish what I have done in hopes that some one else will take up these interesting researches."

Desiring to verify the results obtained by Mr. Woukouloff, especially because they are in contradiction to the principle of the conservation of energy, I have made the following experiments.

The annexed figure shows the apparatus that I used, and which is identical with the one employed by Mr. Woukouloff. I took two piles of different forces, two induction bobbins of different resistances, and microphones of different sensitiveness and resistances. I reversed the position of the bobbins and piles as well as that of the microphones and telephones, at different times, and I constantly obtained the following result: *The vibrations of the plate in the telephone, t^3, were much more feeble than were those of the one connected directly by fine wire with the fine wire of the bobbin*, B.

At all events, this experiment in no wise confirms the theory of Mr. Woukouloff that I set out to verify.—*P. Goloubitzky, in La Lumiere Electrique.*

SIEMENS' EXTERNAL ARMATURE MACHINE.

In addition to the different dynamo-electric machines that have come into use, there is a certain number of types which are based upon very ingenious ideas, and which have nevertheless remained in the condition of experimental apparatus. These latter, in spite of their want of success, are interesting to know about, either because they point out a new road that has been incompletely studied, or because they show, on the contrary, a road that should not be entered upon.

Among such apparatus may be mentioned the *Topf-maschine* of Mr. Siemens, concerning which we have already said a few words. We shall first recall its principles. If we have a magnet with two longitudinal poles in front of each of which there passes a conducting wire, there will develop in each of the two conductors two opposite currents. But, if these conductors are united with each other by their extremities, so as to form a helix, the two currents will be added to each other. If, then, we revolve the helix around the magnet, we shall be able, on interposing a commutator into the circuit, to obtain a current having always the same direction.

This machine, which yielded but little electro-motive force, and had a resistance which was likewise very slight, seems to have inspired Mr. Siemens to construct a machine like that shown in Figs. 1 and 2.

In this apparatus Mr. Siemens has rendered the induced ring stationary and caused the inductor to revolve—the inductor in this case being an electro having the form of a double T iron armature (Fig. 1).

The armature is formed (Fig. 2) of a series of groups of wire wound around an iron cylinder.

The wires of the different groups end in the radial pieces of a hollow collector, and internal brushes, B B′, put them in connection with the internal movable electro.

Supposing that the wires that are attached to the terminals, P, of the movable electro are united with each other, and that we revolve this electro through the medium of a pulley affixed to the axle; then the remnant magnetism of the double T iron armature will induce currents in the external wires, and these currents, gathered up by the brushes, B B′, will re-enforce the revolving inductor, and, after a certain length of time, the current set up will have reached its full intensity.

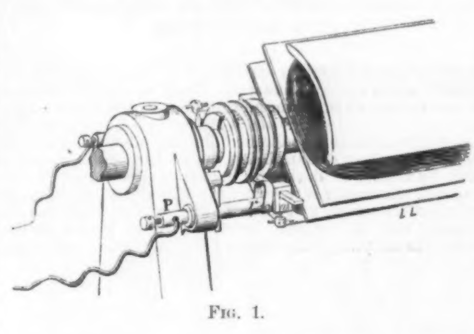


FIG. 1.

It goes without saying that this machine is capable of working inversely as a motor, without, however, presenting any advantage from such a point of view.

Fig. 1 shows how two rubbers, which correspond to two rings fixed on the axis of the revolving armature, permit of collecting the currents set up, or of introducing the current when the apparatus is employed as a motor.

It will be seen that this machine is in fact only a reversed Gramme machine of elongated form, and it is easy to understand that this arrangement cannot prove favorable for a rational production of a current.

The inductor being of limited dimensions with respect to the armature, from the fact that it must be continuous in the interior of the latter, the intensity of the magnetic field cannot possibly be increased beyond certain limits, and there will always result a marked inferiority.

On another hand, the arrangement of the induced wires in the magnetic field is likewise less favorable than when the armature is within the latter, and this is another reason why the arrangement is not advantageous. The machine, then, seems to us to belong to the category of ingenious ideas that are not destined to become the object of a real application, but which present nevertheless a certain historic interest.—*La Lumiere Electrique.*

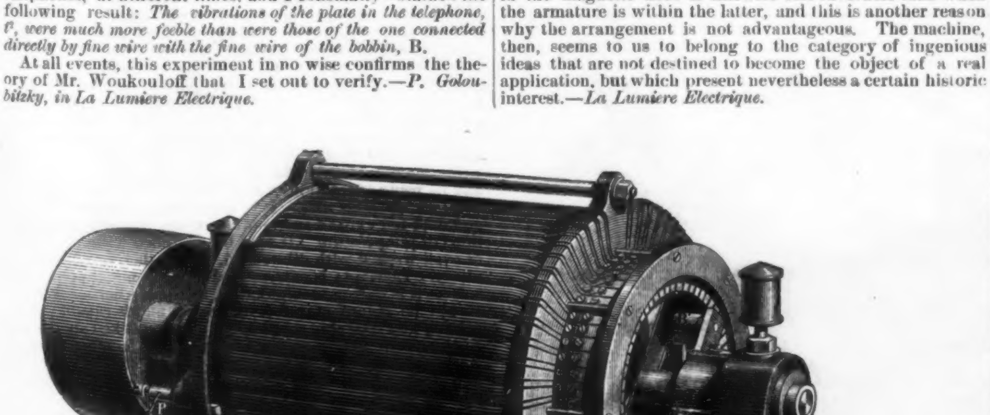


FIG. 2.—SIEMENS' EXTERNAL ARMATURE MACHINE.

SEWAGE DISPOSAL FOR ISOLATED HOUSES.

By GEORGE E. WARING, JR.

It is now clearly and generally understood that the all-prevailing cesspool used for the disposal of household wastes is in every respect pernicious and objectionable. It would hardly be too strong a statement to say that the best cesspool is worse than the best sewer; even where water closet matter is excluded, the condition is not much improved. Thus far the cesspool has been the only means of disposal generally available where there were no sewers.

The slowly growing and carefully matured experience of the past fifteen years has, however, demonstrated the success of the system of sub-surface irrigition, or the disposal of foul liquids by opening jointed drain-tiles laid near to the surface of the ground, within reach of the roots of vegetation, as not only a very great improvement on the cesspool, but as being, in fact, as nearly perfect as the conditions of the case will probably allow.

This system originated, so far as we know, with the Rev. Henry Moule, of England, the inventor of the earth-closet, who published a description of its application in 1868. He had found that the use of the earth-closet was objected to for the reason that it fails to provide for the disposal of the liquid wastes of the house, leaving it necessary that a cesspool or sewer should be resorted to for this purpose, which might as well be also used in connection with water-closets. He tried the experiment of laying an open-jointed tile drain a few inches below the surface of the ground along the foot of a trellis covered with grape vines. The result was a vigorous growth and an improved fruitage of the vines, and an inoffensive and innoxious disposal of the waste liquids.

A few years later, Mr. Rogers Field made use of the same system in connection with the drainage of houses at Leatherhead, supplementing the drains with a flush tank arranged to hold back the flow until it became full, and then to discharge it with one rush into the tiles, effecting thereby a long period of intermission, during which the soil was exposed to aeration and consequent purification, avoiding the constant saturation that a steady trickle from the house-drain would produce at the beginning of the drain, and bringing its whole length into equal requisition at each periodic outflow.

In this form the apparatus was somewhat extensively used in England and elsewhere. At my own house in Newport, where about two hundred feet of absorption tiles performed their office satisfactorily for eleven years, I interposed a settling basin of about one hundsed gallons capacity, in the course of the drain leading from the flush tank to the absorption area. This held back coasser matters and a large proportion of the grease. There was, however, always some difficulty resulting from the adhesion of grease to the outlet of the flush tank, requiring frequent cleaning of the siphon, and, later, such a disturbance of the accumulated matters in the settling basin as caused flocculent and greasy particles to flow forward, and in time to choke the drains. It became necessary, from time to time (three times in the eleven years), to lift the whole series of tiles, wash them, and replace them.

The next improvement was to place the settling-basin between the flush-tank and the house, serving as a grease-trap, protecting the siphon of the flush-tank against the gradual accretion of grease, and leaving only a relatively clear liquid to be discharged into the pipes. This was a great improvement, and practically effected all that was necessary where only the small flow of the kitchen sink was to be taken care of. It was found, however, when it became a question of disposing of the entire waste of a house, including water-closets, baths, etc., that the flow into the settling-basin had at times sufficient force so to disturb its deposits as to cause a considerable amount of semi-solid matter to pass over into the flush-tank, leading in time to the obstruction of the drains. This has been remedied by constructing in the settling-basin a division-wall at right angles to the line of flow, and built to about the height of the ordinary water-level. This wall, dividing the basin into two chambers, confines the disturbance caused by the inflow to the first chamber. The flow from this into the other chamber, being in a thin stream over the top of the wall, does not disturb the deposits, and only the liquid passes into the flush-tank.

It has also been found that, whatever precautions might be taken, it might become necessary from time to time to take up parts of the absorption drains, to cleanse them from occasional obstructions. When such removal of the tiles becomes necessary, it is of the greatest importance that they should be relaid on their exact original grade. To the end that this removal and cleansing may be performed by any laborer, and in an inexpensive manner, it is desirable that the tiles be laid on a foundation that need never be disturbed. Strips of board serve this purpose well while they last; but their decay is somewhat rapid under such conditions, so that it is best in constructing the drain to lay first a line of earthenware gutters, carefully placed and never to be disturbed, and to lay the tiles in these.

Furthermore, whatever precautions we may take to prevent flecks of greasy matter from entering the drains, small amounts of such material will inevitably be carried forward with the discharge, so that if the tiles are laid with close joints, the ends actually touching each other, the narrow spaces, which serve a good purpose at the outset, will in time become choked with deposits, causing the drain to act as a tight pipe, except at those few points where, from breaks or other inequalities at the ends of the tiles, there is an unduly large opening. When the drains are in this condition, the escaping sewage confined to these points, under the pressure of the discharge from the tank, may here and there reach the surface, which is of course objectionable. To avoid this difficulty it is now my custom to require the tile layer to carry a piece of thick sole leather as a gauge, laying the drains with a distance apart equal to the thickness of the leather. Here again might come another difficulty: were such open joints allowed to remain unprotected, the covering earth would work through them into the tiles and cause obstructions. The joints are therefore covered with a short earthenware cap over the top.

In order to leave the space between the tiles as effective as possible for the escape of the sewage, the gutter and the cap are both made with a radius greater than that of the outside of the tile, so as to form a true bed and an efficient cover without hugging the joint, except at the very top and bottom.

These developments of the system, simple though they are, have been slowly worked out to meet the succession of difficulties which have arisen in practice. They have now had sufficiently long application and sufficiently extensive trial to make it prudent to assert the practical efficiency of this method.

It is, in fact, a perfect system for the disposal of liquid household wastes, practically and theoretically, with a

single limitation, viz.: it still involves the retention of a cesspool of very limited size. It is impracticable to allow the discharge of kitchen and water-closet matter, including paper, to flow directly into the flush-tank; it would soon obstruct the siphon, and so much of it as passed on into the drains would soon obstruct these. It is imperative that such matters should be withheld until by maceration or by decomposition they will pass on in solution or in suspension in the liquid flow. In so far as decomposition is necessary, the settling-basin is in a less degree subject to the theoretical objections that are made to the cesspool. It is, however, to be considered that this settling-basin, which is perfectly tight as to its walls, is so small that the volume of water passing through it takes up the products of decomposition, and carries them on to the drains before they assume a condition at all comparable to that of the permanent cesspool. It is found, practically, that the arrangement is inoffensive and safe.

The line of pipe (usually four-inch vitrified pipe) leading from the flush tank to the absorption field, be it far or near, should have its joints tightly cemented. Its fall may be, during the early part of its course, as great as the lay of the land requires, but as it approaches the absorption tiles it should be reduced to 4 inches per 100 feet. Its joints should be tightly cemented until its depth becomes less than eighteen inches from the surface. It should have branch pieces for the connection of the absorption drains delivering from the *bottom* of the main. The absorption drains, of which the total length should be about equal to the number of gallons discharged at each operation of the flush-tank—more in heavy soils and less in light soils—should be laid in gutter tiles, of which the channel should be about ten inches below the finished surface of the ground. The system, carried out as here described, will, I am confident, be found much the most satisfactory that can now be adopted for the disposal of the liquid wastes of country houses, and even of village houses, having a small amount of available land; for example, the absorption ground may, without annoyance, be within 20 feet of the house (as my own was). For a family of six or seven persons, with an ordinarily light soil, 300 feet of absorption drain will be sufficient. As the tiles may be laid in parallel lines not more than four feet apart, there will be required only 1,200 square feet of ground. Small houses, using little water, may be served with a much smaller area.

This system of disposal by absorption drains has been successfully used by a number of architects and engineers, and its application at Lenox, Mass., for the disposal of the entire sewage of the village since 1876, at Sherborn, Mass., for the disposal of the wastes of the women's prison since 1879, and at the Bryn Mawr Hotel, of the Pennsylvania Railroad Company, for the sewage of that extensive establishment since 1881, are practical demonstrations of the success of the method above described.

It is now so perfected in its details that it may safely be adopted for common use.—*American Architect.*

CHEAP HOUSES.

FIGURE 1 represents a design for a commodious country dwelling. But little attempt has been made at ornamentation, the object being to present a showy house at as little cost as possible. The windows being placed in the corners is an innovation on the present popular style of bay-windows, and is certainly much less expensive. This building can be erected for from $4,500 to $6,000, depending altogether upon the styles and character of finishes used.

Figures 2, 3, and 4 show the plan, front and side elevations of a beautiful country dwelling, costing about $3,500. This sum can be varied greatly, as almost double that amount could be used to advantage if extra nice finishes are employed. The amount quoted allows for as nice finish on the outside as is shown by the engraving, and neat finishes inside. The arrangements of the rooms is such as to especially recommend the plan for a country dwelling. Stairs are shown leading to the attic. If desired, the elevation could be made 2½ feet higher than shown, and the design thus changed into a 1½-story house. It will be noticed that the arrangement of the hall is such that in summer a perfect system of ventilation can be had, and in winter, by the use of the hall and other fire-places, the home can be agreeably warmed in every part.—*Cal. Architect.*

LINCRUSTA WALTON.

ABOUT an hour's ride from London by the South-Western Railway, and only a few minutes' walk from the little village of Sunbury, is a factory of a most interesting character, and which we recently visited. This is an establishment for the manufacture of lincrusta Walton, a material which is second to none for the facility with which it lends itself to the production of every kind of art decoration. It is the invention of Mr. F. Walton, the inventor of the linoleum

FIG. 2.—FRONT ELEVATION OF DWELLING COSTING ABOUT $3,500.

floorcloth, and, like that material, it is prepared from linseed oil and a ligneous material. Upon its first introduction it was known as linoleum muralis, but its name was subsequently changed to lincrusta Walton, from *linum*, flax—the chief ingredient being solidified linseed oil—and *crusta*, relief, the inventor's name being added to prevent the adoption, by others, of the word lincrusta after the patent has expired. Lincrusta is the outcome of long and laborious researches on the part of Mr. Walton, who realized the important part his original invention would play if he succeeded in adapting it for use as a wall covering, seeing that

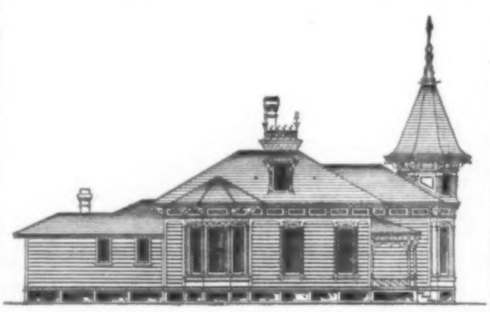


FIG. 3.—SIDE ELEVATION OF DWELLING COSTING ABOUT $3,500.

the superficial area of wall space in every room is at least three times that of the floor space. He therefore perfected the invention, so that lincrusta is now the subject of a very extensive and varied manufacture at Sunbury.

The foundation, or backing, of lincrusta is a combination of cloth and paper, the two being held together by a composition consisting of oxidized oil and other ingredients, which renders the backing waterproof, and the two fabrics are firmly united by passing between pressure rollers. The oxidized oil is also used in combination with a preparation of wood and other ingredients for producing lincrusta itself. Coloring matter of any desired tone is added, the four stock colors being brown, red, sage green, and buff. The lincrusta having been prepared is laid on the backing by machinery, the desired pattern being produced in relief. The perfected lincrusta Walton leaves the machine in a continuous strip of varying width and pattern, according to circumstances and requirements. It is then cut up into lengths and sent to the drying house, where it remains until it is dry, or, to put it more correctly, hardened, and ready for use. This completes the process, and results in the production of the most elegant wall-covering material we have ever seen, a great variety of which we inspected in the stock rooms.

In other parts of the works we found the packing room, and the shed where the packing cases are made. Then there was the drawing office where the designs were being prepared for the engravers. There were also the mechanics'

FIG. 4.—PLAN OF COUNTRY DWELLING COSTING $3,500.

and engineers' workshops for pattern making and for making the machinery employed on the works, together with the smithy and iron store.

The machinery at the works is driven by a horizontal compound engine of 60 indicated horse power, taking steam from a horizontal multitubular boiler of 200 horse power, and which supplies steam for heating the workshops and for other purposes. Such, however, is the increasing demand for lincrusta in its various forms, that the works we have been describing are rapidly becoming unequal to the strain upon them, and a new range of buildings, including a drying and packing shed 120 feet long by 40 feet wide, has therefore been erected, and is now being fitted up. Here the manufacture will be carried on under slightly modified conditions as regards arrangement, the buildings being so designed that the process will be carried out continuously from first to last. The raw material will be lifted to the top floor of the building, and will reach the various machines on the ground floor without being subjected to manual labor, passing on its way through the various processes of manipulation

Having described the manufacture of lincrusta, we will now turn to its physical features, and its numerous applications and uses. It possesses many valuable and unique properties, and among them may be mentioned impermeability to moisture and thoroughly waterproof qualities; resistance to blows; durability; facility of cleansing; the ease with which it can be fixed or removed, its moderate cost, and its ready adaptation to any form or style of architecture, domestic or otherwise. It is also a non-conductor of heat, and does not expand and contract when exposed to alternations of temperature It may be scrubbed without injury, or even washed with dilute acid, and is therefore highly sanitary. Lincrusta is extremely ductile in manufacture, but soft as it is during manipulation, it becomes hard afterward. It can be manufactured in any color, and is capable of receiving and retaining mechanical printing (like calicoes and linoleum) or elaborate hand painting in gold and colors. Such a wall surface enhances the artistic effect of pictures and works of art, while it affords to them absolute security against damp.

The durability of lincrusta when exposed for a long period to weather—a crucial test—is evidenced by some strips which we examined at Sunbury. These strips had been fixed to the outer wall of the factory at various dates, one as far back as March 19, 1879; and it was surprising to see their excellent state of preservation after three and four years of exposure to the extremes of climate and temperature. This would indicate its applicability for external decoration, and such an application would undoubtedly improve the aspect of many of our streets. Considering the advantages lincrusta possesses in this respect, it is by no means improbable that we may one day see it utilized in this direction.

With regard to its present applications, we can only say that their name appears to be legion. Besides being extensively used as a wall covering, it is largely employed for lining railway carriages—notably those of the Lancashire and Yorkshire Company—and the saloons and cabins of vessels belonging to the leading steamship companies, for mouldings, picture frames, door-panels, finger-plates, book-covers, table mats, and, in fact, for every possible decorative and useful purpose, for which it is well adapted, as it is—as we have shown—susceptible of being moulded and pressed

FIG. 1.—DESIGN FOR A COUNTRY DWELLING COSTING $4,500 TO $6,000.

into the most elegant forms and delicate patterns. Such is the nature, and such are the attributes of lincrusta Walton, which for combined elegance and utility must certainly rank as one of the most important inventions of the present day.—*Iron.*

ENAMELING.

By MILLWAY VANES.

ENAMEL art is progressing in England, and that which progresses in England is reflected in America. Art pottery is now to the fore; and in both countries its advancement is looked forward to with much interest by both governments and peoples. The tariff question, in this interest, is no small factor: and each nation, judging according to its apparent interest, is seeking to extend by commerce what it produces by manufacture. But in this difference I take no part, being content to assist both England and America in the perfecting of art, *per se*, and the advancement of mankind in all that is beautiful in form and true in sentiment. To this end, as a practical potter, I am about to give, in the first place, a few hints on enamel painting, and then proceed to other papers of a kindred character.

In enamel painting, the work of art is more for copying than for original painting. The same freedom of touch is not obtainable in enamel painting as in water color drawing, or in oil painting. In the two latter great facility can be obtained in the handling; and the touch for character, in trees and drapery, can be given with rapidity and efficiency.

TOILET MIRROR IN SILVER, PARTLY GILT AND SET WITH PEARLS AND PRECIOUS STONES, AFTER A DESIGN BY PROFESSOR C. SCHICK, CARLSRUHE, EXECUTED BY ZACH. ZIEGLER, JEWELER, NUREMBERG.—*The Workshop.*

At one coloring, by the hand of a master, a water-color drawing, or an oil painting, can be given the effect of high finish, while the colors are wet, and the work of two, three, or four colorings may not be required. This can never be accomplished in enamel painting. An enamel painter requires two, three, or more "fires" before the artist can obtain the effect he desires. This is caused by the want of transparency in, and the crude character of the colors used, the tones of which can only be brought out by firing. In oil painting this is obtained at once in the hands of a master by laying in the opaque colors and finishing in transparent colors, the highest lights in oil painting being obtained by impasting on the colors as thick as possible. In the clouds of Constable's oil paintings, I have noticed that the artist has used the pallet-knife to obtain the effect he desired. In enamel painting, especially in flowers, the high lights are taken out by the tip end of an uncolored pencil, which the artist first applies to the tip of the wet tongue, and then takes out the lights of the picture, leaving the white ground bare. This requires technical skill and technical knowledge. The vehicles used require careful selection, and the colors should be ground to the highest degree of fineness by the artist himself, on a small slab, with a glass muller. These colors should be ground in the rawest spirit of turpentine; and when thoroughly ground, should be placed by the pallet-knife on a piece of plaster of Paris "bat," to draw all the turpentine out and thus leave the color in a state that might easily be reduced to the finest powder. This powder might be stored away in pill boxes, and, when used, should be mixed on a pitcher slab about six or eight inches square.

Enamel colors might be had from the color-maker of any pottery; but should the potter desire to make his own, there are any quantity of recipes to be obtained from the managers of works, but few can be depended on only after practical trials. I give a few here, taken from the rough book of a manager, but cannot vouch for their purity.

Enamel Blue.—64 oz. flint glass, 20 oz. red lead, 4 oz. pearl ash, 8 oz. white enamel, 4 oz. common salt, 6 oz. best blue calx. To be run down in the glost oven, then ground, and add 4 oz. of red lead; then grind it, and it will be fit for use.

Another.—26 oz. zaffre, 18 oz. pearl ash, a teaspoonful of charcoal.

Violet Blue.—4 oz. tartar, 2 oz. red lead, 5 oz. flint, 1/8 oz. magnesia.

Another, said to be no better in use.—1 part niter, 15 of glass, 5 of red lead, 1 of potash, 1 of white enamel, 1¾ of blue calx.

Another.—14 parts glass, 5 of red lead, 1 white enamel, 2 of blue calx. Good.

Another.—10 parts glass, 5 of red lead, 2 of niter, ½ of white enamel, calcined, ½ of blue calx. Good.

Flux for Blue.—16 lb. flint, 2 of lead, 2½ borax, 1 of pearl ash.

Yellow.—8 of litharge, 6 of flint, 3 of antimony, 2 of ocher, 4 of glass.

Another.—3 of litharge, 4 of powdered brick, 1 oxide of iron, 3 of antimony; to be calcined in glost oven, and spread on glost plates.

Flux for Yellow.—3 oz. red lead, 1 oz. flint.

Another Enamel Yellow.—6 lb. white lead, ½ lb. of flint, ½ lb. tin ashes; to be mixed well together, run down in an enameling heat, and poured into warm water.

Carnelian Red.—1 part chromate of iron, 3½ of flux.

Flux.—3 parts red lead, 1 of glass, 1 of flint. No other flux will do for this. The flux must be highly calcined, until it forms a dark glass.

Another Enamel Red.—3 of litharge, 2 of antimony, 1 of iron scales.

Another.—1 of litharge, 1 of antimony, ½ of iron scales, red and yellow, to be spread on plates in glost oven.

Flux for Red.—6 oz. of red lead, 4 borax, 2 flint glass. To be run down over common fire.

Pink.—100 lb. oxide of tin, 50 lb. chloride of lime, 5 lb. oxide of chrome; 10 of the foregoing to 1 of flint.

Rose Colors.—1 grain of gold, dissolved in aquaregia; 4 of block tin, dissolved in same; pour each separately into a basin of cold water, then drop in the tin, when dissolved, and stir with a feather; then let it stand six hours, until precipitated; then wash it in hot water; after which add the following: 3 parts borax, 1 of flint and 1 of calx.

Rose Flux.—14 parts glass, 5 of red lead.

I place little importance on these, as they might be had in any quantity. When in a powder state and well ground, they are ready for mixing with the proper vehicles on the color slab. These vehicles are raw turpentine, the oil of turpentine, and the oil of tar. The turpentine is placed in a gallipot, which is again placed in a saucer. The turpentine, in time, fattens, and creeps over the edge of the gallipot into the saucer, and "fattens" into the oil of turpentine, which can be thinned by raw turpentine for use. To this should be added another gallipot and saucer, containing tar oil. Now here comes the technical use of these vehicles. The colors should not be made too "fat," or left too "raw." I have said that the lights in enamel painting are taken out by the pencil, always a camel-hair one. If the color be too "fat" this cannot be cleanly done, or if it be too "raw" a similar evil is encountered. To perfect the color, in use, a little tar oil is mixed with it, and occasionally used in taking out the lights. This was the manipulation, or *modus operandi*, of one of the greatest painters—one of the finest wild-flower painters in the world; and in my experience I have followed the same practice with the best results.

To the camel-hair pencil should be added the stick, or holder, which performs some of the most important work in the art of enamel painting. It should be made of alder wood, and sharpened at the end away from the pencil. With this the artist takes out the sharpest and most brilliant lights of the picture, occasionally cleaning the end of the pencil-stick on the front of his working-coat, and then wetting on the tip of his tongue for a cleaner touch.

There are no art materials, possibly, so diversified in quality as enamel slabs for painting on, and enamel colors for use in enamel pictures. All these colors, being of a mineral character, require the best chemical mixing and the finest grinding. Rose colors and purple, having bases of gold, are sometimes tampered with in the use of a baser material in the manufacture of those colors; and blues and reds are difficult of obtaining for pure art purposes. A great enamel artist used in his blues a little chloride of sodium, or common salt; and his rose colors and purples were generally of the first make. This artist had worked in England on the finest wares, at Swansea, Worcester, Coalport, Chelsea, the Staffordshire potteries, and elsewhere. Specimens of his clever work might now be seen at the Liverpool Museum. At the great works of Minton's and Copeland's, he was one of the first hands; and no doubt is now well remembered by those who do honor to the trade. From these great manufactories the best of colors might be obtained, not by purchase, but from the kindness of the employers, who are ever ready to assist in the development of art, as the quantity required for art purposes and amateur use is so very small.

Having secured an unblemished porcelain slab, or other porcelain article, the subject might be sketched in with a little Indian ink, rubbed up in water, then the work is commenced for the first firing. The work can either have a background or can be painted without one; and here the skill of the artist is first tried. The background in the first coloring might be "bossed" in with a small "dabber," and then the subject taken out and arranged, of course, according to the lights and darks and colors of the picture. First, second, third, and perhaps a fourth firing may be required as the work goes on, shadows darkening, tints brought out, and the background receiving the most beautiful and effective stippling, until at last this work of art stands out before the admiring gaze of the beholders, a finished work of technical ability, gorgeous in colors, most deep and rich in tone, and defying all the power of time in permanency of hues. But even here a few other touches might be required, and another firing given. To this end the artist, before alluded to, used a little white enamel, mixed in water, giving the finest dots, as it were, for seed-pearls, and the work was finished.

As before stated, enamel colors are prepared from the oxides of different metals with a vitreous flux. The principal colors are oxides of lead, platinum, chromium, uranium. Oxides of tin and antimony give opacity.

THE BLISTERING OF PAINT.

THE subject of the blistering of paint has from time to time engrossed the attention of practical men; but, so far as we can follow it in the literature pertaining to the building trade, its cause has never been clearly laid down, and hence it is a detail enshrouded in mystery.

We propose, in the present notice, to lay down some general rules that govern this phenomenon, if we may so call it, and from the same to draw some practical conclusions, the object of which will be to set the question at rest.

The blistering of paint is in a large measure traceable to the position of the painted surface—it is usually found on work presenting a south aspect, or exposed to the full rays of the sun. As a defect it is associated with the summer season, our humid, sunless winters being opposed to its action. The deduction to be drawn from this is that it is the effect of heat. Paint, we know, is a body both mineral and metallic, made into a plastic state by oil, the object of which is to keep out the moisture from exposed surfaces in our buildings and other works, and to offer, on internal works, a uniform and pleasing surface to the eye. The oil used is linseed, which, by boiling, attains setting or drying qualities, its thick or heavy nature, when loaded with mineral and metallic matters, being let down for temporary or working purposes by spirits of turpentine, a volatile spirit that is a mere aid to the spreading of the paint. Paint so largely composed of oil will never fairly set or assume a dry state, one uninfluenced by heat. However dry and brittle it may appear, it is capable of being rendered soft and plastic by the application of heat, and hence the hand stove of the painters is the most ordinary instrument for the removal of old paint. We mention this, for it is clear that, approach the subject as we will, we find heat the prime cause of the blistering of paint.

Closing in with our subject, and bringing it into narrower lines, we find blistering, properly speaking, wholly confined to wood as a base or ground work. It is true it is not unknown to iron or plaster; but in these cases it is variant in form, and not blistering in the true sense of the term. The blistering of paint on iron is not traceable to the softening of the paint, and the shelling up of the same; but to water making its way to the naked iron, through some crack or defect in the paint, and becoming an active agent in oxidation. The blister, thus formed, is clearly the separation of the film of paint from the iron, by the formation of rust upon the face, which, as a foreign material, forms an effectual separation of the two bodies. The extension of these blisters is dependent upon the supply of water, and, unlike the true blister, is not dependent upon heat, or a south or sunny aspect. The blistering of paint on iron occurs in any aspect or position in the full light, or in the dark, in the summer or the winter, the destructive agent being water; it is dependent upon no other conditions. The blistering of paint upon plaster is in a large degree analogous to that of

iron, inasmuch as it is formed by the disintegration of the base by the action of water. Painted plasterwork, so long as water can be kept from percolating through the cracks or faults, or gaining entrance from above by filtration, or from below by capillary action, is a highly durable material; but the moment water gains a footing, the lime, in some degree, is dissolved, and upon being removed and redeposited, undergoes the process of recrystallization; a powdery substance is thus formed, that comes as a stranger between the paint and the plaster, in which respect it bears a strong resemblance to rust, the result of the oxidation of iron. Large faces of plaster are subject to fractures from expansion under the heat of the sun, or from the lifting of the upper members of a building, consequent upon the admission of water from gutters or copings, the lifting being the result of secondary crystallization set up in the joints of mortar. We thus get an explanation of the fact that the blistering of paint, so to speak, always occurs in the neighborhood of cracks or fractures in the plaster, and is more pronounced in the cornice or upper part than in any other part of a building. In proof of its being the result of crystallization, the face of the plaster is always found to be covered over with powdered lime. The painter, finding this, takes care to saturate the disintegrated face of the framework in effecting repairs: but this, as he finds to his chagrin, is no protection against the recurrence of the evil, for so long as water or moisture is admitted at any point, so long will this abnormal blistering ensue. The blistering of paint upon plasterwork, like that upon iron, is not dependent upon heat; it is a chemical action set up by water upon a body of dry lime in partial state of crystallization; it is caused by the lime dissolving and its removal—it may be in but an infinitesimal degree—and its recrystallization. Upon the water evaporating, the result is a dry powder that works an effectual separation between the film of paint and the ground work of plaster, and it does not attach itself to either of the bodies, but remains a powder until the film of paint or blister is removed, when it may be dusted off with a brush.

The blistering of paint upon wood is distinct in its order, and is the general blister known in the trade. It occurs on the face of woodwork exposed to the sun, and is traceable to the influence of heat. It is not pronounced in the case of new work, where the body of paint is not great; but it is a great evil, and an eye-sore on old work, where the coats of paint are layered one on the other. Wood, as a groundwork, is a porous body, highly charged with moisture in a natural state, and never free from it in a so-called dry state, when used in exposed situations. It may be taken that wood, during the winter season, or one-half of the year, is absorbing moisture. We may see this in our outer doors, our gates, our sliding sashes, and our shutters, for the joiner is constantly being called into requisition to ease the same. This moisture, so largely present in the atmosphere, cannot be kept out of the wood by the most careful painting. In our shop-fronts it has ready access to the back of the woodwork, the face sides being the only ones that are painted; in our doors and gates it is absorbed from the sills or the ground, from the fact that the lower edges are unpainted. There is always some portion of the woodwork hid from the eye which is unpainted, and there the system of absorption is active during the winter or rainy season. Wood in this state, during the hottest days in the summer, will make efforts to throw off this moisture. We then find the heat of the sun applied with great force to the painted face, and the unpainted face to be in the cold shade. The effect of this powerful heat is to draw the moisture to the face of the wood, where its course is arrested by sundry impervious coats of paint; it is here generated into steam, the expansive power of which forces away the paint, and the familiar blister is formed. Paint, as a mineral or metallic body, does not incorporate with the wood—it simply adheres thereto, forcing its fronds, so to speak, in the pores of the wood, and filling up the interstices formed by the bundles of fibers. Hence we find that paint fails to adhere to highly resinous or greasy woods, and the knots themselves, from being hard and compact, must be faced with knotting composition as a ground for the paint. Paint, in parting company with wood, or, in other words, forming a blister, will adopt one of two courses:

1st. To tear itself clear from its association with the wood. Examined with a glass it will be found to have a rough underface, the exact counterpart of the porous face of the wood. It will resemble the inner face of beech-bark, which presents innumerable vertical plates, the casts, as it were, of little interstices in the woody face of the tree.

2d. To tear itself clear from the first coating or priming on the face of the wood, the outer coats only forming the blister. This latter is the most ordinary course followed by heat or steam blisters; but in cold-water blisters, a form of blister not generally known, but one upon which we shall offer a few remarks, the first of the above courses is followed, and the paint as a body is forced from the wood.

It must be understood that there are certain well-defined laws regulating the blistering of paint. The groundwork must be a soft, porous, absorbent wood, in which a sufficient amount of moisture is present to create steam beneath the impervious coating of paint. The paint must be of sufficient body or texture to be impervious. If it is thin, the natural accompaniment of new work, it will not blister, for it is not impervious, and the steam will escape into the rarefied atmosphere; and hence we find blistering wholly associated with old work upon which a great body of paint is present.

The remedy for this ordinary steam-blistering of paint is, on the one hand, to paint the back side of the wood, as well as the ends and edges, and so prevent the absorption of moisture during the wet or winter season. This, we admit, is a most difficult operation. On the other hand, hard, close, unabsorbent woods, like mahogany, should be used as the groundwork where practical; failing these, the body of the paint should be thin, light, or semi porous, and not dense and impervious. Proof of this is found in paint which has accumulated in thickness being removed by the hand-stove to prevent blistering. This is done upon soft wood as a basis, but not upon hard wood, iron, or plaster. A deal might be said upon the removal of paint by heat and chemicals, such as potash, Egyptian clay, and other compositions; but we refrain from touching upon it from the fact that it is outside the heading of this chapter.

A blister upon iron will be found to embrace the whole body of the paint, and to be ferruginous on the inner face, showing that the separation is in the iron itself. A blister upon plaster will, in like degree, embrace the whole body of the paint, and be coated with lime or powder on its inner face, showing that the separation is in the plaster; indeed, this is patent, for the blister will often be found with a thick coating of plaster adhering to the same, showing that the disintegration has occurred in the body or center of the plaster. This is a well-known fact, as, upon the repainting of plaster faces, the bricklayer is often brought upon the scene to repair the damage and restore the face for the painter.

A blister upon wood does not necessarily embrace the whole body of the paint, as the separation will often take place between the priming, or first coat, and the subsequent coats, and it never brings away a backing of the groundwork, unless the wood be rotten, in which case it cannot be called a blister, but a falling in or giving way of the groundwork. The rotting of wood with a painted face is a pronounced illustration of the absorbent nature of wood, when associated at the back or unprotected face with damp or moisture; such wood, if exposed to the sun on the painted face, will be the first to blister, and that which is the driest and least absorbent in its texture will be the last.

The blistering of paint upon wood is not, as is generally believed, the direct effects of heat upon the oil in the paint; if it were, we should find it taking the same action upon iron or plaster, which, we need scarcely say, is not the case. Heat in the case as above noted is a secondary agency, the primary one being steam generated from the moisture in the porous wood below or behind the impervious face or coating of paint: it is truly speaking a blister; but it is also a blow, expansion, or cavity, caused by the generation of steam. Blisters formed on wood, if cut or pricked at an early stage, so as to let out the steam, may be erased by carefully rubbing them down to their original bed, especially so if the separation has taken place on the face of the wood, in preference to the face of the priming or first coat of paint.

In our researches on the subject under notice, we have been materially assisted by investigating the rare phenomenon of cold-water blisters on painted woodwork. In December last, the contraction of the lead in the gutters of a house erected in the first quarter of the present century, of the expansion of the water allowed to lodge therein, by the action of frost, caused the lead to split, and upon a thaw ensuing water made its way into the interior of the house. In its downward course it took a cupboard, built in the recess of a chimney on the first floor, every part of which was saturated. The door has a moulded architrave wrought in Quebec pine; one of the jambs of this architrave imbibed an abundance of water at the miter, which, coursing down the wood by natural gravitation, displaced the paint, and blisters appeared upon the surface identical with those formed by heat on woodwork exposed to the sun.

Here was a case of blisters forming in the depth of winter on old internal woodwork, in a position where the sun at no time could shine or act upon it. These blisters, unlike those formed by steam, under the influence of the sun had a baggy appearance, as if weighted or loaded with water. Upon marking their position we found them to be traveling downward at the rate of about one-quarter of an inch per day. These blisters, upon being pricked or cut, gave out their water, and the skin of paint allowed itself to be rubbed down into its old position, where it adhered after the supply of water had been cut off. We found that the paint, as a body, had detached itself from the naked wood, and that its inner face was an imprint of that porous body.

Water, as we know, is foreign to paint, for paint will not adhere to wet or unseasoned wood. In like manner, old paint will detach itself from wood, if the wood is highly porous and charged or saturated with moisture. In the case in point, the head of the architrave, where the grain or pores of the wood was fixed in a horizontal position, did not blister on the face. The blisters only occurred in the upper part of the architrave forming the jamb, in which the grain or pores of the wood were in an upright or perpendicular position. The vessels were here weighted or charged with water, which as it worked to the face forced off the paint and lodged in blisters so formed by its agency.

Blisters so formed by cold water, gravitating or coursing down the fibers of the wood, suggest the fact that they are formed with the exercise of but little force, and they prepare us for the admission that the generation of steam by the action of the sun is sufficient to account for their presence on ordinary woodwork. It must be borne in mind that the formation of these cold water blisters could not occur except on very soft or porous wood. We were not prepared to admit that the architrave in question was so hard or dense in its texture as even Baltic red or yellow fir; or if it was fir, that it was then a wholly porous sap wood. On investigation we found it to be the ordinary Quebec pine, a very light, soft, porous, sponge-like wood—a class of wood highly suitable for the development of such a phenomenon, but one whose porous nature throws great light upon the subject of blistering of paint.—*W. S., in The Building News.*

THE PROPORTION OF CARBON WASTED AS SOOT.

PROF. W. CHANDLER ROBERTS says: Earlier experiment, have indicated the limits within which this proportion of soot will probably be comprised. M. Delezenne estimated in 1855 that the proportion of carbon that escaped combustion in this form might be taken at five per cent. of the total weight of fuel burnt in the grate, and that 6320 kilogrammes of soot fell in twelve hours on the town of Lille. But, as Emile Burnat, quoting Payen, pointed out in a paper on the combustion of smoke in boiler-furnaces, the amount of finely divided carbon produced in a certain *lamp black* factory is only three per cent. of the coal burnt, and therefore the amount of carbon in ordinary smoke must be much lower.

In 1858, Mr. John Graham estimated that very black smoke does not contain more than $\frac{1}{10}$ per cent. of the carbon of the coal burnt, and the accurate experiments of M. Scheurer-Kestner showed that in boiler furnaces the loss of carbon in the form of soot never exceeds 1 per cent of the fuel burnt, while the mean loss is probably between ½ and ¾ per cent. As might be anticipated, the amount of soot is greater in the case of an open fire-place than in a boiler furnace; but the evidence afforded by the results of the tests made at the exhibition, does not, unfortunately, render it possible to give a precise answer to the question, for the following reasons: Some of the soot must have been deposited in the flue before it reached the point at which the withdrawing tube was inserted; and there is reason to fear that in the withdrawal of flue-gas laden with soot through any form of slit or orifice in a tube, the gaseous and solid portions may not enter in exactly the ratio in which they exist in the chimney.

In many cases, the flues were carefully swept before and after the trial, and the soot was collected and weighed. In an extreme case, in an open fire-place, no less than 2¼ per cent. of soot, compared with the fuel burnt, was found in the flue at the end of the trial. In the case of three close stoves of careful construction, rather less than ½ per cent. was found, while in some cases it fell to ¼ per cent., and in one case to $\frac{1}{20}$ per cent. Of course, these numbers do not include the amount escaping into the air. I may perhaps add that in a preliminary experiment, made with an ordinary open fire-place connected with a chimney by means of a sheet-iron pipe six feet long and nine inches diameter, 17 pounds of bituminous coal were burnt in three hours, and no less than 0·61 per cent. of the fuel burnt was collected in the pipe in the form of soot, while the soot that passed into the chimney was not collected. This 0·61 per cent. of soot, after drying at 100 degrees C., yielded, on distillation at 300 degrees C., 12 per cent. of an oily, strong-smelling mixture of hydrocarbons.

THE INFLUENCE OF EFFECTIVE BREATHING IN DELAYING THE PHYSICAL CHANGES INCIDENT TO THE DECLINE OF LIFE, AND IN THE PREVENTION OF PNEUMONIA, CONSUMPTION, AND DISEASES OF WOMEN.

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INTRODUCTION.

WHEN we consider the enormous mortality caused by preventable diseases, we must concede that if there be any means easily and universally available, both by rich and poor through the use of which the human body can be fortified, so as to be enabled to resist more successfully the disease producing influences to which all are subject, even under the most perfect cleanliness of person and surroundings attainable, such means should be made known and employed throughout the civilized world.

The development of the breathing function up to the full requirements of the system constitutes the most effective means for securing that internal cleanliness which alone is next to godliness, and without which external purity is comparatively powerless to prevent disease.

Believing that adequate prominence has not been given to these truths by the sanitarians who have so ably discussed sanitary science in all its other branches, I have written this monograph to emphasize the extreme importance of adequate respiration in the prevention of several very prevalent and fatal affections, and to show that we have at our command safe and simple means by which the breathing powers can be effectively developed, and to indicate how they should be used to attain the ends in view.

ON THE DIGESTION OF FOOD.

As the measures I advocate for the prevention of disease are based on the latest teachings of the highest authorities in the science of physiology, and their application to the purpose in question is but the practical use of demonstrated scientific truths, it will be necessary to give a sketch of the digestive and respiratory processes, so that the popular reader may more readily understand why the benefits claimed necessarily attend the diligent use of the prescribed treatment.

The stomach is commonly believed to be the organ in which the whole digestive process occurs; this is an error. Digestion is begun in the mouth, is continued in the stomach and the intestines, the whole complex operation being finally completed only when certain nutritive principles have been submitted to the action of the liver.

Physiologists divide food into three great classes—albuminoids, fats, and starch. A large proportion of all grains and other edible vegetable products contain starch. The lean of meats and the white of eggs are notable examples of the albuminoid variety of food, while butter, the fat of meats, and oils are properly known as fatty food.

The chief use in the living body of starchy, saccharine, and fatty food is to develop heat. These substances are burnt in the system just as truly as coal is burnt in stoves: the chemical process in both cases is identical; in the former it is to supply internal, in the latter to furnish external heat. The chief function performed by the albuminoid variety of food is to supply the waste arising from physical wear and tear.

Besides the three great classes alluded to, food contains another very important though subsidiary class of saline matters, comprising compounds of sodium, potassium, phosphorus, sulphur, iron, etc., all of which are requisite in adequate proportions for perfect nutrition. Although the foregoing are, briefly stated, the chief functions of the various food elements, yet they mutually assist each other in the proper performance of their several duties in the living system, and if either of them be altogether absent, or the quantity present be insufficient, then the physiological operations in the living body of all the others are proportionately disturbed.

By way of illustration let us trace the various digestive processes undergone by a ham sandwich before it can be fitted to contribute to the nutrition of the body.

This well known and justly esteemed article of diet contains all the elements of nutrition in suitable proportions requisite both to build up and warm the body. The needed starchy element is found in the bread, the albuminoid in the lean of the meat, and the fats in the butter.

Before proceding farther let me observe that the active principles of the various digestive fluids, the saliva, the gastric juice, and of the pancreatic fluid, are known as ferments. A "ferment" is a substance having the power to alter the chemical constitution of other substances, and to render them more soluble. Yeast used by bakers to liberate carbonic acid gas by which bread is made light is the most familiar example of a ferment.

When a portion of the aforesaid sandwich has been masticated, it is mechanically reduced to a pulp, but no digestive change is produced in the mouth on any of its nutrient principles except on the starch; this is, however, rapidly converted into soluble grape sugar by the action of the ferment existing in the saliva. If the process of mastication has been adequately performed, nearly the whole of the starch will have become sugar while in the mouth; but if the bolus of food be swallowed too quickly, a much larger proportion of the starch will go into the stomach quite unchanged. The sugar resulting from the conversion of the starch is rapidly absorbed into the blood from the stomach, but the farther conversion of starch into sugar is stopped by the acid gastric juice, the salivary ferment being operative only in an alkaline medium. The starch which has escaped salivary action passes unchanged through the stomach to the intestine, where it meets with the pancreatic secretion by which its complete conversion into sugar is effected. No digestive change whatever is produced on the fatty part of the food either in the mouth or in the stomach, except that it is melted by the bodily heat. As soon, however, as it passes out of the stomach into the intestines, it is vigorously acted on by the pancreatic juice, feebly assisted by the bile. Through the digestive power of the former the fats are converted into an emulsion, consisting of myriads of microscopic globules of oil, fats of all kinds being reduced during digestion to the liquid condition by the heat of the body.

In this emulsified condition it is fitted for absorption into the blood.

The lean (albuminoid) meat having been crushed and comminuted during mastication, finds its way to the stomach, where it meets its proper solvent, the acid gastric juice, the action of which is greatly assisted by the muscular movements of the stomach, which keep the mass in motion until complete solution be effected. Any undigested starch that may be present in the stomach, along with the digested albuminoids and the fats, is then passed on through the pylorus to the intestine, where the digestion of the whole mass is completed by the powerful action of the pancreatic secretion. After the completion of intestinal digestion, the starch which has been converted into grape sugar, with the dissolved albuminoids, find their way into the intestinal veins, while the emulsified fat is absorbed by the lacteals, which convey their contents by a more circuitous route, also into the general blood circulation.

Whatever portions of the food which are incapable of being digested, such as cartilage, the seeds and skins of fruits pass downward toward the large intestines, where they contribute to form the fæces.

THE MECHANISM OF RESPIRATION.

The chest, containing the lungs, heart, and great blood vessels, is an airtight box which is completely filled by its contents, the elasticity of the lungs being such that they readily adapt themselves to every normal variation of its size.

The interchange of air between the lungs and the atmosphere is brought about through the play of purely mechanical motions, by which the air pressure in the lungs is alternately increased and diminished; air is thus made to flow into and out of the bronchial tubes, which everywhere penetrate the pulmonary organs. By the descent of the diaphragm, and the contraction of the muscles upon and between the ribs, the size of the chest cavity is increased in every direction; the pressure within the lungs being thus reduced below that of the atmosphere outside the body, air rushes into the bronchial tubes until the lost equilibrium has been restored. These motions constitute an inspiration. The inspiratory movement having reached the maximum, the muscles concerned in the expansion of the chest instantly begin to relax, and the elasticity of the chest walls and of the lungs causes them to contract on the contained air, when a portion of it equal to the quantity just inspired is expelled. This is known as an expiration. The inspiratory and the expiratory acts constitute a respiration.

In tranquil breathing which occurs automatically without the supervision of the will, the lungs and chest never attain the maximum expansion of which they are capable. By forced respiration a very much larger quantity of air can be drawn into and expelled from the lungs. The total amount of air contained in the lungs at the height of a forced respiration has been divided as follows: All the air which can be inhaled by the deepest possible inspiration over and above that which is introduced in ordinary tranquil breathing is called the *complemental* air.

The *tidal* air is the volume which flows in and out of the lungs during ordinary respiration. The *supplemental* air is that portion which remains in the chest after the usual automatic respiration, but which can be readily displaced at will. The *residual* air is that portion which cannot be displaced by the most powerful effort, and which consequently remains in the lungs, being altogether beyond our control.

The amount of air which can be made to flow into and out of the lungs by the deepest respiratory movement has been called by Dr. Hutchinson the *vital volume*. Experiments conducted on a large scale by him show that this amount is less dependent than might have been supposed on the absolute external dimensions of the chest, being influenced much more by the elasticity of the pulmonary structures—that is, the vital volume increases in a direct ratio with the resiliency of the lungs, the mobility of the chest walls, and the power of the respiratory muscles. Dr H. shows that two sets of men of the same stature, one measuring 35 inches around the chest and the other 38 inches; the average vital capacity of the first was found to be 235 cubic inches of air while that of the second was only 226 inches.

The following table represents the vital capacity that is regarded by Dr. H. as necessary to health at the middle period of life in the male for each inch of stature between five and six feet, and the diminution it undergoes during the various stages of consumption:

	Vital capacity in cubic inches.			
Height	In health.	1st stage.	2d stage.	3d stage.
5·0 to 5·1	174	117	99	82
5·1 " 5·2	182	122	103	86
5·2 " 5·3	190	127	108	89
5·3 " 5·4	198	133	113	93
5·4 " 5·5	206	138	117	97
5·5 " 5·6	214	143	122	100
5·6 " 5·7	222	149	129	104
5·7 " 5·8	230	154	131	108
5·8 " 5·9	238	157	136	112
5·9 " 5·10	246	165	140	116
5·10 " 5·11	254	170	145	119
5·11 " 6·	262	176	149	123

To be able by forced breathing to respire a large quantity of air would be of less value in estimating the influence of normal respiration on health were it not found that when the vital volume is large the tidal air, or the quantity flowing in and out of the lungs during tranquil breathing, is increased in the same proportion. The latter, being constant, has the most important influence on the physical well-being. It is estimated by the same authority at from sixteen to twenty cubic inches at each inspiration. When the volume of the tidal air is below the normal requirements of the system, it is most readily and directly increased by augmenting the vital capacity.

CHANGES PRODUCED IN THE RESPIRED AIR AND IN THE BLOOD BY BREATHING.

The requirements of the respiratory process demand that both the air in the bronchial tubes and the blood in the pulmonary capillaries be constantly renewed, hence the necessity for the circulation of the vital fluid. The heart is that great central organ by which the primary impetus is imparted to the blood current; it is divided by a partition into a right and left side that are capable of acting quite independently of one another, each side controlling its own distinct circuit of blood; the right side propelling the pulmonary and the left side the systemic blood circulations. It is therefore very properly spoken of as consisting really of a left and a right heart, these having been joined in one organ apparently for the purpose of economizing space and material. The changes undergone by the blood while traversing these two circuits differ very materially, and are influenced very largely by the changes simultaneously taking place in the air flowing in and out of the bronchial tubes.

The route pursued by the systemic current of blood is from the left side of the heart into the arteries, thence through the capillaries which deliver it to the veins; the latter discharge their contents into the right side of the heart, at which point its course is completed. The pulmonary blood current, leaving the right side of the heart, proceeds in a ceaseless stream through the lungs back to the left heart, from which it started.

While the respired air remains in the lungs its temperature is raised, it absorbs moisture from the blood, and parts with a portion of its oxygen to the vital fluid and receives carbonic acid gas therefrom in return. On the other hand the blood while traversing the pulmonary capillaries receives oxygen and surrenders carbonic acid, by which interchange it is purified and revitalized. The immature blood coming from the lymphatic system also receives in the lung capillaries its complete vivification, a change that is signalized by the blood altering in color from a dark purple to a bright scarlet. The vital fluid having received a supply of vivified nutritive material and a fresh supply of oxygen, it starts on its course through the body generally to surrender to the needy tissues nourishment and oxygen, and to receive carbonic acid gas and waste matters in return.

THE INFLUENCE OF OXYGEN IN THE ELABORATION OF DIGESTED FOOD.

So long as nutritive materials remain in the digestive organs, although they may have undergone perfectly the various digestive processes, they are not more subservient to the nutrition of the body than if they were applied to the external surface. The body is covered on the outside by the skin and the digestive passages are lined by another skin, the mucous membrane, which invests all internal parts that communicate with the exterior. Between these two surfaces lies the scene of the vital operations. Before food can subserve the vital purposes it must not only be liquefied and changed by digestion, but it must pass into and become assimilated by the blood, through the circulation of which nutritive matters are carried and delivered to all the needy tissues.

The capacity possessed by the living body to vitalize the nutritive materials absorbed by it is, perhaps, its most wonderful physical endowment. Through the operation of this power the food consumed yesterday, to-day forms part of the organs by which we see, think, hear, feel, and move.

Thousands of years ago the great Lawgiver of the Hebrews said of the body, "The blood is the life thereof."

The beginnings of the process of converting digested food into living blood may be observed shortly after the chyle has been received into the lymphatics; during its passage through these vessels and the mesenteric glands it undergoes important vital alterations, which gradually assimilate it to the constitution of the vital fluid. Therefore it seems to be that while passing through the vessels by which it is absorbed from the digestive cavity that it becomes progressively endowed with the mysterious life principle. But this process, although it is begun and continued in the lymphatic system, is not completed until the venous blood containing the immature vital fluid has been exposed to the influence of oxygen while passing through the lungs. If the previous elaboration of the fluid has been perfect and the respired air contains the vitalizing gas in adequate quantities, the food that was eaten a few hours before now becomes rich, scarlet, arterial blood, admirably fitted to discharge its complicated duties to the living body.

As in chemical manipulations a definite quantity of an alkali is required to saturate an acid of given strength, in the same manner, in the vitalization of digested food, a definite quantity of the vital gas oxygen is required to enable the living system to complete the vitalization of a given quantity of food. A man requires about two pounds of solid food per day, and very nearly the same weight of oxygen is absorbed from the respired air; therefore we shall not be far from the truth when we assume that an atom of food requires to be acted on in the living body by an atom of oxygen, in order that its complete vitalization may be effected. From these considerations we are justified in regarding the whole lacteal and lymphatic system as constituting one vast assimilating and blood-forming apparatus, the wonderful transformations of which are completed in the lungs under the influence of the vital gas, oxygen.

THE INFLUENCE OF OXYGEN ON THE CIRCULATION OF THE BLOOD.

During the early growth of the child, previous to birth, vessels are formed and a blood circulation is established in them before a heart is developed capable of effective work. All the vegetable world and a majority of the animal creation are destitute of hearts, yet the fructifying juices flow freely upward, against the influence of the law of gravitation, from the roots to the topmost twig of the greatest trees. And the blood circulation seems to be as perfect in those animals that are destitute of hearts as in mammals, who are provided with a complicated cardiac apparatus.

The popular idea that the heart is the sole cause of the circulation is thus shown to be an error. The movements of the blood through the capillaries, of the contents of the lymphatics, and the motions of the muscular fluids are altogether independent of the heart's action. The chief function of this organ is to impart the initial impulse to the vital current, so that the arteries shall be always full, thus presenting an abundant supply of the vital fluid to the pulmonary and systemic capillaries, through which it flows mainly by the operation of a physical law discovered by the late Professor John W. Draper. He taught that this law consists in an attraction or affinity possessed by the blood for the sides of the vessels in which it moves. Notable examples of the operation of Dr. Draper's law may be cited. For instance, if a number of capillary glass tubes of different diameter be dipped into water, the latter will rise in the tubes above the level of the surrounding liquid; the smaller the diameter of the tube, the higher will the water rise. The most familiar example of the operation of this law is observed in the ascent of coal oil in the wick of a lamp; the fibers of which the wick is made form a series of capillary tubes; the oil rises through them by the force of the affinity it has for the cotton, and it continues to flow upward in a steady stream as long as the oil is removed from the top of the wick by combustion.

The ascent of the sap of plants occurs by virtue of the same physical conditions; it continues to ascend through the capillary tubes of which all plants are composed as long as the watery part escapes from the leaves. In the human blood circulation the following conditions obtain:

We have on one side the arteries containing blood rich in oxygen and the elements of nutrition; on the other side, the venous blood, which has been despoiled of the vital gas and largely exhausted of nutrient properties; between these lie the capillaries that receive the vital fluid from the former and deliver it to the latter. While the blood passes through the capillaries, the exchange of nutritive material between it and the tissues occurs. Now, arterial blood containing oxygen with which it is ready to part must necessarily have a greater affinity for the capillaries than venous blood that has lost its oxygen, therefore the arterial blood enters the systemic capillaries, drives before it and expels on the other side of the capillary plexus the blood that has lost its affinity for the walls of the capillaries while traversing them. An important factor in the problem is the attraction of the tissues themselves for arterial blood; this contains the material adapted to the nutrition of all the several tissues, the bony, the nervous, the muscular, etc.

Each several tissue has an elective affinity for the special matters adapted to its nourishment. Therefore blood containing these elements is powerfully attracted by the tissues requiring such nutriment, hence the circulation of the blood toward them. As soon as the required matters have been abstracted by the needy tissues from the blood, it loses it affinity by parting with its nourishment and its oxygen and by the absorption of carbonic acid gas and waste matters, and it is pressed on by the unchanged blood behind it. Therefore the motive power of the capillary circulation is chiefly the affinity possessed by the blood for the sides of the minute blood-vessels and the tissues which it is intended to nourish. But this affinity exists in a normal degree only in blood that is duly charged with oxygen introduced by adequate respiration. Dr. Draper says: "In my view of the subject it is therefore the arterialization of the blood in the lungs which is the cause of the circulation in man. I consider the circulation as the consequence of respiration, and though in one sense the minor causes are numerous, each portion of nervous material, each muscular fiber, every secreting cell working in its own way, these subordinate actions are all referable to the primordial act, and that is the exposure of the blood to the air."

Whatever, therefore, interferes with the respiration, interferes with circulation. If an irrespirable gas be thrown into the cells of the lungs, the passage of the blood is instantly arrested and asphyxia ensues. Or if the access of the air be cut off, as in drowning, in vain the heart exerts its utmost convulsive throb—it is unable to drive forward the blood. And in those cases by no means infrequent, yet undoubtedly the most surprising occurring in medical practice, restoration from death by drowning, the whole success turns on one condition, the re-establishment of the arterialization of the blood. If that be accomplished, the circulation is restored and the heart proceeds with its duty.

THE INFLUENCE OF RESPIRATION ON THE NUTRITION OF THE BODY.

The function of nutrition, considered in its widest sense, embraces the whole series of vital operations by which nutritive matters are digested, absorbed, vitalized, and appropriated by every part of the body, including those retrogressive changes through which the same materials are removed from the system after they have subserved the vital purposes.

The materials required for the sustenance of the body may all be included under three heads: air, water, and food. The Creator has beneficently adapted the supply of these necessaries to the urgency of the want. Breathing must continue without cessation, but what is as free as air? The necessity for water is not quite so imperative, and this liquid has been made almost as accessible as air. The demand for food is much less urgent, and to man has been said, "By the sweat of thy face shalt thou eat bread."

The amount of food required varies widely in different countries and among different races and individuals. A calculation by the late Professor W. H. Draper, based on an examination of the diet scales of the English and French navies, led him to the conclusion that the average quantity of dry solid food required per day by a man in actual life was about two and a quarter pounds avoirdupois, or upward of 800 pounds per annum; he also estimated that about 1,500 pounds of liquid were taken, as water, tea, coffee, etc., and that the weight of oxygen entering the system by means of respiration was about equal to that of the food. The materials required for the sustenance of a man in the course of a year, therefore, exceed one ton and a half, or more than twenty times his own weight. All this vast amount is received into and assimilated by the body to maintain its integrity and to render possible the evolution of power, whether that be nervous, muscular, or intellectual. After having done its duty, it is removed as waste matter.

These pregnant facts afford us a glimpse of the rapidity of the changes ever going on in the living body. Modern science has exposed the fallacies of the old physiologists, who taught that what they called the vital principle endowed the body with the power to resist change, and that this occurred only when life was extinct. The truth is that the living body submits to unceasing waste, which is the inevitable result of vital activity; and if proper supplies of nutritive material be withheld, it soon perishes. Thus it is absolutely true that our bodies are ever dying.

The sole difference between this ever occurring interstitial death of atoms and final dissolution consists in the fact that, in the first instance, no sooner does one atom of a living body die than a living atom is supplied from the blood to take its place and perform its functions; in second instance, the whole fabric returns to dust as it was.

The essential condition of physical life is the continual death of the atoms of which the body is composed, and their renewal by the operation of the nutritive process. Decay is, in fact, more truly a part of life than it is of death, because it goes on unceasingly during all our physical existence, but after dissolution it ceases when the work of decomposition has been completed. The living body is like the flame of a lamp which may present the same aspect from hour to hour, but the incandescent particles of matter of which it is composed pass upward through it in a ceaseless stream. The body is like a noble mansion built of wonderfully wrought but perishable materials, the integrity of which is only preserved by repairs as ceaseless as the decay.

The rate at which the living body undergoes destructive change and renewal is much more rapid than is commonly supposed. It has been ascertained that a corpse will so resist decay, although no means have been taken to preserve it, that at the end of three and a half months the features will retain the aspect they wore during life, so that the individual may be recognized and the age told, while another month elapses before the features become unrecognizable and the large muscles of the body finally yield to decay.

On the other hand, experiments of too elaborate a charac-

ter to be detailed here have proved that all the soft parts of a healthy human body are removed through destructive atomic change and completely renewed by the nutritive materials consumed as food in about three months and a half. Therefore, dead flesh and living flesh are equally perishable. What a significant corroboration by modern science on the words of the Book, "All flesh is grass, and the glory of it as the flower of the grass."

All the phenomena manifested by the living body arise by the mutual action and reaction of the air, water, and the food on each other in the vital domain. These actions and reactions naturally resolve themselves into two distinct series: the progressive and the retrogressive. In the former the nutritive matters are digested, absorbed, vitalized, and appropriated by the living body as part and parcel of itself.

The absolute necessity of the oxygen received into the system by respiration to the carrying forward and completion of those wonderful processes by which the living body is built up and vitalized has justly earned for it the name of *the vital gas*.

The oxygen entrapped in the bubbles of saliva during the mastication of food and swallowed along with it enables the gastric juice to act more effectively on the food submitted to its action; the solution of albuminoid food is thereby materially aided.

I have already stated that chyle gradually acquires the properties of blood while it is passing through the lymphatic system of tubes and the glands connected with it. Chyle corpuscles are developed there that eventually become red blood globules; the following facts seem to be conclusive on these points:

Chyle drawn from the thoracic duct and exposed to the air coagulates like blood under the same conditions, and the clot becomes reddened in consequence of the absorption of oxygen by the chyle corpuscles from the air, showing that the immature blood is already competent to profit by the vitalizing influence of oxygen, to which its complete conversion into living blood while passing through the capillary vessels of the lungs is finally due.

Therefore, in every step of the nutritive processes from the beginning of digestion to the assimilation of the vitalized atoms into the living tissues, including the circulation of the blood, the oxygen introduced into the body by respiration is an essential element. Without this vital gas all these complex opertions promptly cease; and if the quantity of oxygen be deficient, the vital processes and the material they elaborate for the nutrition of the body must be defective in a direct ratio with the meagerness of the supply.

After the living atoms have remained in the body a certain length of time, they are surrendered to the retrogressive or destructive series of changes by which they are reduced step by step to the inorganic condition; appearing finally as carbonic acid gas, which escapes by the lungs and the water, ammonia, sulphates, phosphates, etc., that are eliminated by the kidneys.

All the waste matters of the body arise therein by the oxidation of the food and the tissues, and without the influence of oxygen the reduction of the bodily debris to the gaseous and soluble forms by which their perfect elimination of the body is favored would be impossible. Therefore it is evident that if the quantity of oxygen introduced into the body by breathing be inadequate, both the building up and the pulling down of the body and the disposal of the effete substances arising therein must be defective, causing in the first place various functional disorders, and, sooner or later, irremediable organic diseases and premature death.

CONDITION OF THE BODY WHEN RESPIRATION IS AND IS NOT DEFECTIVE.

The extreme importance of breathing is also shown by its urgency. Food and drink, especially the former, may be dispensed with for many days without destroying life, but if respiration be suspended for only a few moments, the vital spark is soon extinct forever. The immediate effects of a total cessation of breathing are the accumulation of carbonic acid in the blood and a stagnation of the circulation, first in the capillaries of the lungs and afterward in those of the system generally, with an accumulation of blood in the venous system. As long as the heart continues to beat, blood of a depraved quality and in steadily diminished quantity is sent to the nervous centers; this blood exerts on them a depressing influence, so that consciousness is speedily extinguished, and the respiratory movements cease. The contractility of the heart is not finally lost, however, as soon as the breathing stops; for some time after, the left ventricle may be again set in motion by supplying it with arterial blood. Therefore, if the circulation has not been arrested too long, it may be renewed by artificial respiration. The entrance of fresh air into the cells of the lungs restores the circulation through the pulmonary capillaries, allows the venous blood to flow to the lungs; this relieves the distension of the right side of the heart and conveys to the left the necessary stimulus to action. The whole vital apparatus is thus again set in motion.

The effects caused by the habitual breathing of a quantity of air but slightly less than the full requirements of the system are developed much more slowly, but they are in the highest degree insidious, and they produce in the end very much the same results—waste matters are imperfectly removed, the blood becomes impure and circulates sluggishly, the strength is reduced and life is brought to a premature end directly or indirectly. Let us study these briefly in detail.

All the materials that can be used as food must be capable of uniting with oxygen. Oxidation is only another name for burning. All the waste matters arising in the body are fitted for removal therefrom by a chemical process identical with that which takes place in an ignited furnace. The combustion in the living body is very much less intense, but it is not the less genuine burning—in both cases it is the union of combustible matters with oxygen, and the chemical results are the same—heat is extricated and ashes remain.

The ashes of the living body are the matters that escape from the lungs, skin, kidneys, and bowels.

When the draught of the furnace is defective, the coal is imperfectly consumed and the fire becomes choked with the debris. When the waste matters in the body are imperfectly oxidized, because the supply of oxygen to the system by breathing is too little, they cannot be totally eliminated unless they are perfectly burned. Under these circumstances they remain in the body to poison it, obstruct the vital operations, and to invite disease.

The human body in its career passes through certain determinate phases: it has an infancy, a youth, a maturity, decline, old age, and death. The same statements are true of the living particles of which it is composed; they are also, so to speak, born, come to full maturity, and die. The atoms of which the body is composed must perish in order that the whole organism may enjoy a prolonged period of existence. The strength of the body is greatest during its maturity So also is the vigor and vitality of the living atoms of which the body is composed greatest when they have attained full development.

When they are removed from the system as soon as their vitality begins to decline, and are replaced by young and vigorous living atoms, the whole body enjoys the highest degree of health and strength. In the same way that the effective strength of armies is preserved by retiring the fighting men before age has deprived them of youthful vigor, and replacing them with men in the prime of life.

During the process of training, the skin of a pugilist becomes clearer, his muscles harder, his powers of endurance greatly increased, and his respiration deepened and lengthened. When fully trained, he is able to endure fatigue and receive blows with comparative impunity that would have prostrated him before being submitted to the training.

All this notable improvement is attained by removing completely from his system all partially worn out atoms and by replacing them quickly by new, vigorous, highly vitalized living particles.

When we consider that all the soft parts of the human body, as before stated, decay and are completely removed in about three months and a half, it is highly probable that under the rapid change of tissue induced by the severe training employed by pugilists the whole of their soft tissues are renewed in much less time.

All these changes are brought about by the union of oxygen with the decaying tissues, the retrograde change of the latter being hastened by active exercise. An adequate supply of the vital gas is essential to the process.

It is true exercise is an important factor in the renewal of the body, but the amount of exercise in which a man can indulge always bears a constant relation to the depth and freedom of his breathing. If the free entrance of fresh air into the lungs be obstructed, muscular exertion cannot be continued.

Therefore it is quite possible that a man who is well advanced in life, whose respiration is adequate to the full requirement of his system, may possess what is practically a young body; while a young man's system, because of inadequate respiration, may be so full of decaying and dead matter that for all practical purposes it is an old body.

We are told that "a little leaven leaveneth the whole lump;" this is due to the fact that a ferment possesses the power of reproductive growth when it is mixed with suitable material and kept at a proper temperature. A small quantity of yeast mixed with a large quantity of moist flour soon permeates the whole mass. The poisons that are believed to be the cause of all diseases that are communicated by contagion or infection are believed to act on the blood like a ferment. They are therefore called the zymotic diseases. Small-pox is a typical disease of this class. If a very minute portion of small-pox virus is placed beneath the skin of a healthy person, it will multiply in the course of a few days so that thousands of times the quantity of virus will be thrown out in pustules on his skin that was originally put into his blood. When the zymotic poisons that are believed to excite other acute diseases, such as typhoid fever, measles, or diphtheria, gain access to the body through the atmosphere, they are liable to produce the same effects as when introduced in a more tangible form, when that is possible.

Many facts have been accumulated showing conclusively that it is the absence or presence of waste matter in the blood of persons who are exposed to the malign influence of zymotic poisons that determines their susceptibility to their influence.

Of course it is an exceedingly important matter from a sanitary point of view to prevent the introduction of these poisons into the system; but there can be no question that the internal purity which is the uniform result of adequate respiration (other conditions being right) is the most effective safeguard against their deleterious action when exposure occurs, because a ferment is only operative in the presence of fermentable material; therefore when a zymotic poison finds access to the systems of persons whose blood is adequately purified by effective respiration, it is almost or quite incapable of causing disease, except perhaps the dose be an overwhelming one, both because the waste matters necessary to its development are not present in appreciable quantity, and because under these circumstances the poison itself is quickly disposed of by the oxidizing process and eliminated from the system as readily as the waste matters normally arising in the system because of its functional activities.

All these facts justify the conclusion that adequate respiration promotes the internal purity of the body and directly contributes to health and longevity by reducing the tendency to the development of internal disorders, besides conferring greater immunity from diseases arising from external morbid influences.

THE INFLUENCE OF EFFECTIVE RESPIRATION IN DELAYING THE PHYSICAL CHANGES INCIDENT TO THE DECLINE OF LIFE.

During infancy and youth the processes by which the body is built up are much more active than those concerned in the removal of tissue, therefore it steadily increases in weight until maturity has been attained. The completion of physical growth and the consolidation of the body is signalized by the development of the physical capacities and powers of endurance to the highest point of which the individual is capable. With a due observance of the laws of health, the bodily and especially the mental vigor can usually be maintained for a long period of years with very little deterioration. During all this time the nutritive processes maintain the weight of the body with little variation; the powers of the organism are directed toward maintaining the system in the condition it attained at maturity, to the renewal of the tissues as fast as they undergo retrogressive change, and to the renovation of the vital force equal to the daily expenditure. But it is inherent in the very nature of all organized beings that the vital action by which their nutritive operations are carried on can be sustained during a limited period only. In the very structure of both plants and animals their doom is written, "Dust thou art, and unto dust thou shalt return." The fiat being operative in the delicate flower and in the cedars of Lebanon, in the moth that lives but a summer day, and in the lord of the creation himself.

During the decline of life the nutritive operations become less active and the body slowly diminishes in weight, the evolution of muscular and nervous energy is progressively reduced, and the general vigor of the body gradually deteriorates. The period of life during which there is the greatest waste, repair is also most active. The energy of the body is directly dependent on the amount and completeness of interstitial death; the removal of decaying material being accomplished in the most perfect and rapid manner. But during the period of decline, although the loss of substance through functional activity be diminished, its renewal is more than correspondingly curtailed. Not only are the bodily tissues renewed with greater difficulty, but the material supplied for their renewal by the nutritive processes is very apt to be of an imperfect quality. For this reason, degenerations of important structures of the following character are prone to occur. The most notable degenerations are the fatty, the calcareous, and the waxy.

Fatty matter is used in the structure of the body to fill up crevices between the various organs and to add grace and beauty to the external outline. It also occurs normally about and upon various internal organs; thus a large quantity of fat is often deposited about the kidneys and more or less of it usually exists on the heart. Up to a certain point, a deposit of adipose tissue in the body is both useful and ornamental, but beyond that it may be regarded as a disease. Although fatty growth may result in excessive corpulence, it is not fatty degeneration. A very important distinction must be drawn between these apparently allied disorders. Thus, an increase of fatty matter may occur on the surface of the heart to such an extent that the whole organ may be covered by a thick layer, and more or less of the same tissue may even be deposited between the muscular fibers of the heart, but as long as the muscular structure retains its normal constitution, none of it being replaced by fatty matter, we may have excessive fatty growth, but not fatty degeneration. In the latter disorder the adipose matter occupies the place of the muscular structure, and in proportion as the latter is replaced by the former the power of the heart to do its part in maintaining the circulation is diminished.

The progress of fatty degeneration of the internal organs is most insidious. No symptoms are developed until the disease has made serious inroads on the cardiac structure.

The heart in common with all the other vital organs possesses very considerable reserve power, which is called into action only when extra muscular exertion is demanded; without such reserve capacity, severe exertion would be impossible. One of the first symptoms arising from fatty degeneration of the heart noticed by the patient is inability to indulge in exercise. Going up stairs, ascending rising ground, or, perhaps, a slight quickening of the step in walking, may cause more or less breathlessness. The sounds of the heart, as detected by the stethoscope, are weak, the pulse is slower than natural, the beats may not exceed fifty or fifty-five per minute. Although the patient may gain flesh, he suffers from general debility. Attacks of giddiness and faintness are common. A ring of fatty degeneration around the cornea may often but not always be observed in persons who suffer from this or other internal fatty changes.

The same degeneration of structure occurs in other vital organs quite as often as in the heart. Sometimes it is observed only in one of them, or all the organs and tissues may be simultaneously affected. When the coats of the arteries undergo fatty degeneration, the vessel becomes unable in the course of time to resist the pressure of the blood flowing through it, and rupture occurs with or perhaps without any notable increase of pressure. When the fatty change takes place in the coats of the small arteries of the brain, laceration may be determined by anything that slightly increases the blood pressure within the cranium, such as a little extra exertion of any kind, or even mental emotion, whether pleasurable or painful. Under such circumstances the hemorrhage takes place into the brain substance. After the blood leaves the vessel it coagulates, the clot thus formed causes pressure on the brain; this and the resulting cerebral changes develop the paralysis of the lateral half of the body. If the hemorrhage has been large enough, it will be promptly fatal, but if it be moderate, the patient will recover his senses after a more or less prolonged period of unconsciousness. After a time the paralysis undergoes a certain amount of spontaneous improvement, but perfect recovery of the power and usefulness of the paralyzed side rarely if ever occurs. In the mean time, if the paralyzed muscles be not subjected to suitable treatment, their structure will be very apt to undergo fatty degeneration from inaction, which, if it be allowed to proceed, will forever destroy the possibility of even partial restoration.

When degeneration takes place in the coats of the large arteries, the pressure of blood causes them to bulge at the weakest part before rupture. These arterial dilatations are known as aneurisms. When they are situated on arteries beyond the surgeon's reach, they rupture sooner or later and then cause sudden death by copious hemorrhage. When the degeneration under consideration occurs in the liver or the kidneys, the functions of these organs are disturbed according to the extent of the fatty change in their structure; in the case of the former the disease is known as fatty liver, in the latter it gives rise to one of the forms of Bright's disease, both of which are necessarily fatal when the degeneration in the tissues of the diseased viscera has proceeded far enough to render the discharge of their functions no longer possible.

The bones are liable to the same sort of change, causing them to become so brittle that fracture has occurred in aged persons, whose osseous tissues are affected by this disease, simply by turning in bed.

Changes in the walls of the arteries and inside the heart occur from the deposit in these situations of the phosphates and carbonates of lime. It is known as calcareous degeneration. The coats of the arteries become thereby rigid and brittle, and are therefore extremely liable to rupture. In the same way the valves of the heart are rendered more or less incapable of performing their duty. When the cerebral arteries are affected, hemorrhage is liable to occur into the brain substance, causing apoplexy, loss of consciousness, paralysis, or sudden death, as in fatty degeneration of the same tissues.

Softening of the brain may gradually supervene because the stiffened arteries can no longer supply enough blood to nourish the brain properly

When earthy deposits take place in the cartilages of the ribs, the flexibility of the walls of the chest is seriously impaired, the respiratory motions, are limited and the breathing capacity greatly diminished. The elastic cushions of fibrous substance existing between the vertebræ may also become ossified by the deposit in their texture of calcareous matter. Under these circumstances the bones become consolidated into one mass, destroying the elasticity and flexibility of the spinal column.

Another form of degeneration called the waxy, from the appearance presented by the cut surface of the tissues affected thereby, occurs in the same situations as the fatty and calcareous varieties and causes symptoms of a similar character.

Such are the chief degenerative changes that are prone to occur during the decline of life, through which the organism

is rendered more and more unfit for the active performance of the vital operations. As they are the natural result of advancing age, these or some other form of degeneration cannot be prevented from occurring sooner or later if life be sufficiently prolonged.

We have already seen that the nutritive processes cannot be effectively carried on in the absence of sufficient oxygen; the production of living material of suitable quality and in sufficient quantity being possible only under the vitalizing influence of an adequate supply of this essential gas through effective breathing.

The respiratory capacity of persons in the decline of life is never, so far as my observation extends, up to the full requirements of the system, except in those rare cases where special attention has been perseveringly given to its development. The breathing power tends to diminish as years roll on, from the gradual stiffening of the chest walls and a diminution of the resiliency of the lung tissue, often long before any rigidity of the thoracic walls has occurred, from calcareous deposits in the cartilages of the ribs.

All forms of degeneration occur because of the failure of the nutritive processes to supply suitable material to replace the natural waste constantly taking place throughout the body. At a certain stage of nutritive failure the parts are repaired by tissue having a lower vitality than that which it is used to replace, and when nutrition becomes still more depraved, repairs are made by fatty, calcareous, or waxy materials, etc., resulting in the degenerations just sketched.

Much can, however, be done to delay the degenerative changes alluded to, as well as the gradual stiffening of the breathing organs up to a late period of life, through timely and judicious measures perseveringly employed, with a view to keep the breathing capacity up to the full requirements of the system. Although hygienic influences of every kind are important factors in promoting longevity, by delaying degenerative changes in the vital organs of persons in the decline of life, yet I feel sure that the very chief of these is adequate respiration. If that be under the full requirements of the system, the others are much less effective.

[*To be continued.*]

MULLEIN LEAVES IN PULMONARY CONSUMPTION.

THE leaves of Verbascum thapsus are popularly used in Ireland in consumption, and the plant, in addition to growing wild, is cultivated in gardens, occasionally on a rather extensive scale. The mullein is administered by boiling an ounce of the dried leaves or a corresponding quantity of the fresh ones in a pint of milk for ten minutes, and giving the strained liquid warm, with or without a little sugar. From his observations, Dr. F. J. B. Quinlan regards mullein as having a distinct weight-increasing power in early cases of pulmonary consumption. The hot decoction causes a comfortable sensation, and when patients take it they experience a physiological want for it. It eases phthisical cough, some patients scarcely requiring cough medicines at all. Its power of checking phthisical looseness is very marked, and it also gives great relief to the dyspnœa; but for phthisical night sweats it is utterly useless. In advanced cases it does not prevent loss of weight.

The decoction in milk is liked by the patient; in watery infusion it is disagreeable, and the expressed juice preserved by glycerin still more so.—*Brit. Med. Jour.*

MENTHOL *VERSUS* PAIN.

By D. M. CAMMANN, M.D., New York.

WHEN the temperature of the oil of peppermint is lowered sufficiently, it deposits small, colorless, prismatic crystals. These are called peppermint camphor, or menthol. Menthol is only slightly soluble in water, but dissolves readily in alcohol and ether, and in oils both fixed and volatile. Until lately it has not been used in therapeutics, but strong oil of peppermint painted over the part has long been a favorite mode of treatment in China for gout and neuralgia. Menthol has antiseptic properties similar to thymol.

In a letter to *The Lancet*, Mr. Macdonald, a student at Edinburgh, records the use of menthol in a solution of one part to sixty of rectified spirits, in cases of facial neuralgia, and writes, "relief was had in from two to four minutes, and within one or two minutes at most, after this, the then existing attack was cured." He also recommends the application of the crystals on cotton wool in cases of toothache. In all my cases the following formula was used:

R. Menthol .... ʒ j.
Alcohol .... ℥ ss.
M.

It may be painted on the part several times daily with a camel's hair brush. No precautions are necessary in its use, except to keep the solution from the eyes. It is rather agreeable than otherwise, except when applied over a large surface it may cause a feeling of chilliness. Several of my patients now keep it always at hand, and apply it when they feel an attack coming on. One of my cases was a boy, seventeen years of age, who had suffered with intermittent fever. At the time of examination he had had no chills for several weeks, but since they had ceased he suffered with severe pains over the spleen, from which he was never entirely free. The spleen was found to be enlarged. He was told to paint the side with tincture of iodine. In a few days he returned, saying the pains were no better. Menthol was then prescribed. A few days after, the pain had entirely disappeared. Another case is of a lady who has had facial neuralgia for several years. She has tried many drugs, including chloral hydrate, bromide of potassium, quinine, and chloroform liniment externally. She is always benefited by quinine. During the last attack she used quinine, and also menthol. She recovered more rapidly than from former attacks, the pain disappearing in a short time. She was surprised herself at the rapidity of her recovery.

In addition to the above I have used menthol in cases of lumbago, facial neuralgia, fugitive chest pains of pulmonary phthisis, intercostal neuralgia, pleurodynia, gastralgia. In all the cases in which internal medication was beneficial, menthol seemed to hasten its action; in some cases in which both external and internal remedies had been without avail, menthol gave relief. In some cases it has failed, but I have been surprised to see that sometimes very obstinate cases have yielded to its influence. It has acted well where tincture of iodine, chloroform liniment, and other local applications have failed. Nor in many cases is the result only temporary; the pain may return after the first two or three applications, but if the treatment be persisted in for a few days a cure may be often effected. It seems, then, that in menthol we have a drug of considerable value in some of the less dangerous but most troublesome ills that flesh is heir to.—*Medical Record.*

HOWARD FRY.

THE sad news of the death of Howard Fry, which was published last week, has caused the most profound sorrow among not only his relatives and near friends, but among a large circle of acquaintances and associates who are to be found in all parts of the country. The expressions of grief have come from all classes with whom he had been brought into contact, and in some cases from those who seemed least likely to appreciate his noble character or be influenced by his example. In truth it has only been since his death that the extent of his influence has been learned, and it has been made apparent that the lives of the humblest employes under him as well as those higher in authority than he all felt the influence of his character, were stimulated by his energy, and made more hopeful and helpful by his integrity and his kind-heartedness.

He was born in England, and at the time of his death was only thirty-six years of age. His father was a member of the Society of Friends, and devoted much of his time, during the latter years of his life, to lecturing in favor of international peace and in opposition to all war.

Howard Fry was married in 1872 to Eliza T. Lawford, the daughter of T. W. Lawford, who is now British Vice-Consul at Baltimore. His wife and four children survive him, the oldest ten years, and the youngest only a few months old. His brother, Clarence Fry, is of the firm of Elliott & Fry, the noted photographers in London. His sister is the wife of Mr. Elliott, and another brother resides in Brighton, England.

He commenced his business career in the shops of the Southeastern Railway, at Ashford, which then were under the charge of Mr. Cudworth. After finishing his apprenticeship, he was made assistant foreman and locomotive inspector at the shop of Bricklayer's Arms in London. While under Mr. Cudworth he was employed part of the time in making experiments in the combustion of coal in locomotives, which, no doubt, had much to do with directing his attention to this subject afterward. Among the devices experimented with was Cudworth's fire-box, with a long and steeply inclined grate, in the efficiency of which Mr. Fry always felt great confidence; and when engaged on the Erie Railway he built a boiler in which this form of grate and firebox were to be used, but before it could be tried he left the employ of the company, and his successors were not imbued with the same faith in it that he had, and it was abandoned.

In March, 1867, he came to Canada and was appointed Locomotive Inspector on the Grand Trunk Road. He remained in that position until January 1, 1868, when he was appointed Assistant Mechanical Superintendent of the Eastern Division. In 1873, when Mr. Watson was President of the Erie Railway Company, he made inquiries for a competent person for the position of Superintendent of Motive Power for that road. Mr. Fry was recommended for the place, and Mr. Watson soon after appointed him with the title of Supervisor of Locomotives, under Mr. Henry Tyson, who was Fourth Vice-President and in charge of the Machinery Department of that line. The difficulties and the complications encountered by Mr. Watson in the administration of the affairs of the unfortunate Erie Company led to his own and to Mr. Tyson's retirement. The latter seemed to open a chance for promotion to Mr. Fry, and there was good reason for his expecting that he would get the appointment of Superintendent of Machinery, if he was considered competent for the place. Unfortunately, when Mr. Watson's successor came into office, Mr. Fry, from motives of delicacy, did not urge his own claims, and no friend acted in his behalf, and another applicant was appointed to the place. It was said that when the matter was brought to the attention of the authority that made the new appointment, he seemed unaware that there was such a person as Mr. Fry in the employ of the company or that he was a person of exceptional ability and unquestioned integrity.

It was a great disappointment to poor Fry. It seemed to him as though at the very threshold of success he had failed, and as though the judgment of his ability, which was thus rendered by those above him, was that he was incompetent for the place he aspired to. There was then no other course left to him but to resign his position, which he did. As soon as the facts became known regarding his relations to the Erie Company, some of his friends secured for him the appointment of Superintendent of Motive Power and Machinery on the Philadelphia & Erie Division of the Pennsylvania Railroad, with his office at Williamsport, Pa., where he went in 1874. He remained there until September, 1881, when the position of Superintendent of Motive Power and Machinery of the New York, West Shore & Buffalo Railroad was offered to him, which he accepted. This gave him an opportunity and opened a career to him which few men in his occupation ever have. It was a new road to extend from New York to Buffalo, for which he was appointed to design the rolling stock, the shops, and all the equipment. The purpose of the managers was to have this done in the very best manner. It was and is intended to be a main line alongside the New York Central Railroad, and to compete with the older road. No expense, nor ability, nor ingenuity which the new road could command was to be spared to make it attractive and complete in every respect. How hard, how ably, and how faithfully the subject of this memoir worked to accomplish the work intrusted to him, probably only those who were closely associated with him know.

Yours very Truly
Howard Fry

Mr. Fry had in a wonderful degree the capacity for investigating all subjects submitted for his judgment. With the most enduring patience and energy he would collect all the data relating to a subject, and, as it were, hold his mind in reserve until he had collected all the available material on which to form an opinion and base his conclusions. He was not a remarkably ingenious man, nor was he a very skillful designer of mechanism, but he had what was perhaps much more valuable to his employers, a judicial mechanical mind. He would listen and give heed to both sides of a question, and weigh all the arguments for or against a given course, and then cutting loose from tradition and prejudice and engineering cant—for there is such a thing—he would form his conclusions from the evidence before him. He was singularly without prejudice and pride of opinion, although he would urge his own views with great vigor when he thought that they were sustained by sound reasons and indubitable facts, and was tenacious of his own conclusions when he was convinced they were right.

He was an active member of the Master Mechanics' and the Master Car-Builders' associations and always took a great interest in their proceedings. He aided very materially in the reorganization of the latter association, and did much to make it successful. At the time the new constitution was in process of formation he assisted by his advice and counsel in getting over difficulties and reconciling interests that were in danger of conflicting.

Of his own character, as known to those who were acquainted with him intimately, no one who knew him in

such relations can write, excepting with feelings of most tender affection. Among all those with whom he was acquainted he was respected, and there was a general feeling of the most implicit confidence in his integrity wherever he was known. A foreigner in a foreign land, he was sometimes placed in embarrassing positions through the ignorant prejudices of those who knew little about his country. In such cases it was amazing to see the patience with which he would bear with their obtuseness, and explain what they seemed so unwilling to understand. The gleaming smile, too, with which he would receive any good-natured chaffing about the Britishers and Yankees, his friends will never forget. It is not too much to say, too, that his intercourse with those engaged in his own occupation, and others collateral to it, has had the effect of diffusing among such people over nearly the whole of this country a kindlier feeling toward the whole English people, and he taught many of those with whom he associated to appreciate how much there is to be learned from British practice, and that not all, nor of all the best, engineering ability is to be found on this side of the Atlantic.

In his willingness and eagerness to help those below him, he had what is a characteristic trait of a great man. He felt much sympathy with working-men, and took a deep interest in everything that promised to elevate their character and condition, although he was without toleration of those who neglected their duties, or were disloyal to their employers. Among the trying events of his life was the strike of the men on the Erie Road while he was engaged there. It is too long ago and the facts are too much faded from view to express judgment on the conduct of the strikers or those who opposed them, but it was a touching incident, when all that was left to honor, except the memory of him who resisted their efforts years before, was brought over the Erie Road, as the car came through Susquehanna these same men placed on it a basket of flowers with the simple words, "Not forgotten."

But although there is so much that is inexpressibly sad in his death, he has left behind him an example of a noble career which is open to all. He was taken away on the

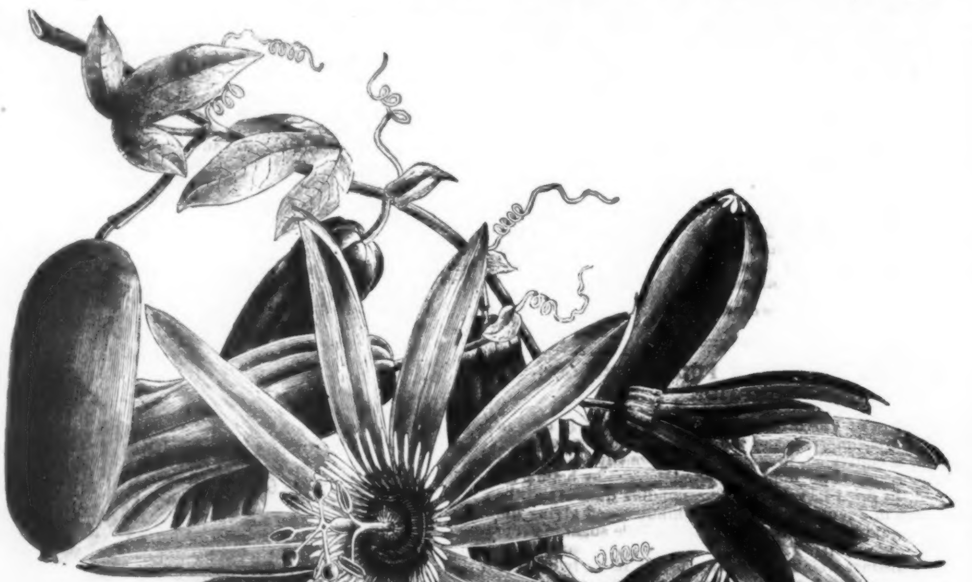
SPATHIPHYLLUM HYBRIDUM, N.E.BR.: SPATHES WHITE ON BOTH SURFACES.

very threshold of success, and before he had reaped the reward which the succeeding years of his life would have so certainly returned to him. He accomplished what he did, in this country at least, without the personal influence of any one excepting those who were attracted to him by the certain indications of his ability, intelligence, and integrity. It is no uncommon thing to hear young men lamenting that there is no career open to them, because they have none of that rather vague thing called "influence." In the life of Howard Fry we have an example of how a man, without any very great advantages of education, nor supereminent ability, coming a stranger into a new country where he was unknown, and by simply manifesting that he was true, honest, and faithful, and that he knew how to perform his duties, can succeed so as to be honored, and can achieve what is worth much more than wealth. He was an example of a man who was willing to be poor in order that he might be honest, and those who are on the threshold of life may be certain that their integrity will not last long, if there is not back of it the same readiness to forego the gratifications which wealth promises, for the sake of retaining an entirely unblemished character.

But there was more in the life of Howard Fry than an illustration of a successful resistance to merely sordid motives, and of the achievement of success in his calling by honorable means. To those near him he somehow made life seem much better worth living, because of his companionship, generosity, and helpfulness. He took great interest in his occupation and its duties, and he regarded it not merely as a means to the end of money-getting, but he took pride in his work in the broad sense that to do it faithfully and to advance the general knowledge of it helped to make the world a more desirable place to live in, and its occupants more comfortable and happy. He was always ready to entertain suggestions which indicated in any way how railroad accidents could be prevented, or which would make the occupations of railroad employes less dangerous. He was one of the most ardent advocates of the use of the block system of running trains. That he should have been taken away by an accident which that system would have prevented is inexpressibly sad. No words that can be spoken or written can make it seem less so. His life is, though, an example of a man who sought success, yet subordinated his efforts to achieve it to the fixed purpose of retaining his integrity, and who never even allowed the bloom to be brushed from his character, nor the fragrance of his reputation to be sullied. His memory will always inspire those who knew him well with faith in what is right and true, and of hope in the future of mankind, if, he showed, men, under the ordinary circumstances of life, may still live as nobly as he did.—*M. N. F., in Railroad Gazette.*

PROFESSOR EICHLER.

THE figure, which is reproduced from a drawing sent us by Messrs. Haage & Schmidt, relieves us from the necessity of giving a detailed description. As will be seen, in habit, foliage, and inflorescence the plant resembles *P. racemosa* (syn. princeps); but the color of the flower is intermediate between that of racemosa and that of Raddiana (kermesina); the tube is cylindrical, longitudinally furrowed, purple



PASSIFLORA PROFESSOR EICHLER: FLOWERS, ROSY LILAC.

within, the sepals being claret red, or plum-colored on the outside, lighter within, the petals rosy-lilac. The outer threads of the corona are pale violet with white spots, the innermost shorter, and of the richest purple. The gynophore is cylindrical. The flowers are larger than those either of racemosa or Raddiana, and the petals are nearly as long as the sepals. The arrangement of the coronal threads differs from that of either of the species named. Messrs. Haage & Schmidt describe the flower as "coppery-carmine" in color, and their representation shows the flower a little larger than in the specimen sent.—*The Gardeners' Chronicle.*

As illustrative of the progress of plant knowledge Hippocrates described 234 species; Theophrastus followed with 500. Pliny knew 800. Tournefort described 10,146. Many of these had to be united as not distinct enough for modern science, till at the death of Linnæus 7294 had been described. De Candolle, in the "Theory of Elementary Botany," made 300,000 named species. Lindley, in 1853, gave the number as 92,920. Now nearly 150,000 species are known.

POPPY CULTIVATION IN MACEDONIA.

THE cultivation of the poppy, both for opium making and for the sake of the seed for the expression of oil, seems to be attracting considerable attention in Macedonia. It is stated in a recent report that some seventeen years ago the first attempt to grow the poppy was made by a Turkish farmer in Istip, with a handful of seed which he had brought from Kara-hissar, in Asia Minor. The experiment proved a complete success, and was renewed on a larger scale in the following year, since which it has annually increased and flourished and extended into adjacent districts. The crop for 1881 amounted to about 135,000lb. of opium and 5,600,000 lb. of poppy seed. Most of the drug was exported to the United Kingdom, at prices ranging from 12s. 6d. to 14s. per pound.

It is stated that the Macedonian opium, especially that produced in the district of Istip, is very pure, containing about 11 per cent. of morphia; while that of Smyrna contains scarcely 9 per cent. Poppy seed was exported from Salonica chiefly to Germany and France, to the extent of some 4,000,000 lb., and at a value of about 13s. per 100 lb. The Turkish Government, with a view to encourage the development of this industry, remits the tithes on opium and poppy seed for one year in the case of lands that are sown for the first time with poppy seed, and distributes in the agricultural districts printed instructions on cultivating the plant and extracting and preparing the drug. In these instructions poppy seed is described as being of two kinds—one white, the other of a darker hue; the seed is known as "Khashkash," and the fruits are called cocoons. The flowers of one kind are described as being generally of a red or purple color, while those of the other are white.

The opium extracted from the white-flowered form is obtained in larger quantity, and is of better quality than the other. To extract the oil the seed is first pounded, then heated, and the oil expressed while the seed is still hot. The oil is used in Europe in the composition of water and oil color paints, and also for burning in lamps, besides which it is said to be "used in the manufacture of glass shades." Another kind of oil is obtained without heating the crushed seed, and this has a pleasant taste, and is used in the preparation of food. The mode of collecting the juice is well known,

and varies but slightly with that adopted in other poppy-growing countries. At Kara-hissar the work of puncturing or scarifying the poppy heads is generally begun early in the afternoon and continued until nightfall. As the opium must be collected twenty-four hours after the scarifying has been concluded, the following day, soon after twelve o'clock, they begin on the one hand to collect the opium from the heads which were cut the day before, and also to scratch the other heads, which work occupies them until the evening.

In order that the exact season for collecting the juice may not be missed, the whole work must all be gone through and finished in from five to ten days. The proper time has to be carefully watched for puncturing the heads of fruit, for if they are cut, say, ten days before or after they are quite ripe, there is no yield of opium. Sometimes it happens that a dry wind begins to blow at the very time when the poppy heads should be cut, and the atmosphere becomes chilly in consequence. During such weather the yield of opium is very small. The fruits also should not be cut during rain, for the rain washes away and destroys the juice as fast as it exudes from the seams that have been cut for it.

"After the opium crop has been gathered in, the pods [fruits] change their previous hue of either green or yellow to rose color. When this change takes place, the poppy plants should be taken up by the roots one by one and collected into small bundles; each bundle should then be bound by a young green withe, and then so placed upright in the ground that the roots of the plants be covered, in which position they should remain for a few days, until the seed contained within the pods shall have become thoroughly matured and dry. Then the pods should be thrashed with a stick until the break open, when the seed may be collected.

"Another method is to sever the stem of the plant at the knot, which is to be found close up to the pod, with the finger and thumb, and after collecting the ends so severed, to spread them out to dry in some open place, and then to break them open by thrashing, or else to pull them to pieces, and after sifting the seed unil it is quite free from extraneous matter, to collect it."—*The Gardeners' Chronicle.*

BREEDING AND MANAGEMENT OF SWINE.

By A. W. ROLLINS.

I GIVE below the result of some of my reading and experience connected with the breeding of swine, but my observations must necessarily be from a breeder's standpoint rather than as a feeder for the packer, as my experience has been almost entirely that of a breeder.

In breeding swine, the first thing is the selection of the boar to be used in the herd. This is a very important matter, for it has been well said that "the sire is one-half the herd." In all cases where good results to be attained are desired, the male *must be a thoroughbred* of which ever breed that may be deemed best; and here we cannot afford to be niggardly, but should be willing to pay some respectable breeder a good price for a hog. Assuming that a good male has been selected, two extremes should be avoided in his future care and management. One extreme is to confine him in a close pen where no exercise can be had, feeding on rich, concentrated food, sometimes only corn and water, resulting in his failure as a getter, for which the breeder is usually blamed. The other extreme is to turn him out with the entire herd, to "root, hog, or die," or rather to fight and fret until he becomes the worst-looking hog on the place, and then the breed that he represents, as well as his breeder, is blamed for the bad results that follow. I have known high-priced pigs only eight months old to be treated in this manner.

The right way is to keep the boar by himself, when not in use, in comfortable quarters, including shade, and water when practicable; but exercise must be had. Feed should be rich in bone and muscle-forming material, with grass or roots at times. Do not, under any circumstances, let him run with sows, and remember that one good service is better than more, after which they should be separated. It would be much better not to use the boar until nearly or quite one year old, and not excessively until two years old. The sow should be of the rangy order, but not spindling. In selecting sows, avoid those with coarse heads as much as possible, as a large, coarse head does not indicate a profitable feeder. Do not let the brood sows have free access to corn with the fattening hogs, but rather feed on any mill feed rich in nitrogenous matter that is calculated to keep the bowels open and promote thrift.

A grave mistake is committed by many in continually breeding from young sows, and saving sow pigs from these young sows for future breeding. I have seen the best results from matured sires and dams. Possibly the reason for this constantly using young sows is the belief that it costs more to winter over the old sows than the younger ones. This is certainly a mistake, as sows that have attained their growth can be kept on far less than those that are yet growing. Perhaps, too, the breeder thinks that the older and larger sows will bring more money in the fall on account of their extra weight, and so keeps the younger ones to breed from. Sows can be profitable until they are from four to six years old, if they show themselves to be good, careful mothers. As a rule, the best results come from pigs born in April and May, after all danger from cold nights is over, and then on properly managed farms the sows and pigs can get a taste of grass or other green food. The pen that the sow is to farrow in should be warm and dry, at least 7x7 feet in size, and provided with six-inch boards or rails around the sides of the pen, about eight inches from the floor, so that the little fellows can find a safe retreat and avoid being crushed by a clumsy sow when in the act of lying down. But little straw should be furnished her at first, and that must be fine, otherwise the little pigs get tangled in the long straw. Separate the sow from the rest of the herd from one to two weeks before she is to farrow, and the system made free from fever by cooling, laxative food, for two months previous to pigging. For twenty-four hours after farrowing she should have nothing to eat, but all the water that she needs. If the water is cold, the chill should be removed by the addition of sufficient warm water. The sow should be fed very sparingly till the pigs are at least a week old, and then, as circumstances may seem to warrant, the feed may be increased in quantity and quality. Diarrhœa in young pigs is usually caused by the fact that the sow has been overfed, in which case the sow should be fed very light for a day or two. Sometimes too much heating food before and after farrowing produces a milk fever, which may be known by the udder being hard and feverish. The pigs cannot live long on milk from a sow in this condition, and if the sow does not die she is generally ruined for future usefulness as a breeder unless the remedy is applied in the first stages of the fever. From fifteen to twenty drops of tincture of aconite root may be given in water or milk, or anything that the sow will drink, twice a day until the trouble is removed.

We are never troubled with sows eating their offspring, and believe that a feverish condition caused by constipation, improper food and conditions, are in most instances the cause of this unnatural craving or appetite. The pigs may be weaned at from eight to ten weeks old, and previous to this they should be taught to eat by having a trough containing milk and mill feed where they can find ready access to it.

Pigs, after weaning, should have more or less milk, as it is one of the most economical as well as profitable feeds that can be furnished them. Scalded or cooked mill feed fed when yet slightly warm is better than cold or raw feed for the young things, and should be fed liberally; and bear in mind that while feeding pigs *all* the proper food they will eat up *clean* may be termed "pampering" by some, yet the man who practices it will certainly have the largest bank account. Those who spend their time looking for a breed of swine that, will succeed and thrive from first to last on corn and water only, do not find them, and are constantly changing from one breed to another, wondering why the neighbor that, uses some *common sense* in feeding has so much better *luck* than they have. You must feed something besides corn and water if you wish to succeed Pigs do not do well in very hot weather if deprived of shade and water. Where nature does not provide these essentials, artificial arrangements should be made that will answer the purpose.

In fattening hogs, I have seen and known of good results from feeding soaked and cooked corn. In fact, remarkable and well-authenticated stories are told of hogs that gained three pounds per day on cooked corn, or three times as much as those in the same locality on dry corn. I know that if fattening hogs are fed several times a week on slop made of bran and mill feed, with pumpkins, beets, or artichokes, they will return a *much larger* amount of pork for the corn eaten than those fed on corn and water alone. Two bushels of corn and one of artichokes will make more pork, as a rule, than will three bushels of corn alone, for the reason that the roots aid digestion and promote health.

I have never had any cholera in my herd, and where contagion does not occur, am sure that the hygienic methods in case of swine spoken of in the foregoing remarks will obviate any tendency to diseases of that nature. The sooner we give our breeding hogs more liberty, and quit the exclusive corn and water diet, the sooner we shall receive more profit from our swine and have less disease.

In regard to the best breeds of swine for Kansas, I would recommend the dark breeds, as Berkshire, Poland-China, Jersey Red, and Essex, for the white hogs do not seem to do as well in our State, owing to their liability to skin diseases caused by our peculiar climate; and while I may have a preference for a particular breed, yet I can see merit in other breeds, believing that there is room enough in our great State for all. It does really seem, though, that if the past five years be indicative of the next five, the two leading breeds, Berkshire and Poland-China, will soon be so similar in appearance that a man without a previous preference would be puzzled which to choose.—*Report Kansas State Board of Agriculture.*

ON THE DISPOSITION OF COLOR-MARKINGS OF DOMESTIC ANIMALS.

By WM. H. BREWER, of New Haven, Conn., Professor of Agriculture in Yale College.*

FOR some years I have been making and carefully recording observations on the color-markings of domestic animals, and have made it the subject of two papers read before the Connecticut Academy of Sciences (April 19, 1876, "On the color-markings of horses," and Sept. 17, 1879, on "Some facts about the color-markings of domestic animals"). Those papers have not been published further than in the most meager and imperfect newspaper notices. The present paper covers the same ground, and is offered here partly that I may have the suggestions and co-operation of other observers, and partly to publish facts which have had but a limited publication before. The tables of numerical results upon which some of the conclusions are based will be published at another time.

First. Many horses of otherwise solid colors, particularly bays, browns, and blacks, have what are called white feet, that is, with more or less white just above the hoof, the legs otherwise being black, or at least of a darker color than belongs to the neck and body of the animal. This marking usually consists of a belt of white hair extending entirely around the leg, varying in extent from a mere white ring just above the hoof, to a long stocking extending far up the leg and ending abruptly and sharply; more rarely the white constitutes a mere spot, and when thus restricted, it is oftenest on the hind side of the leg. The hoof may or may not share the white color, but is liable to be white if there is white hair immediately above it.

Observations made in several different parts of the country, and extending to several thousand foot-marked horses, *show that more of the white feet are on the left side than on the right.*

The left hind foot is the one most often marked, and the right fore foot the one least often, the order of frequency of white feet being the left hind, the right hind, the left fore, the right fore. When three feet are marked, two of them are oftenest on the left side. When only the two feet on the same side are marked, they are most often the two left feet.

The relative frequency of each of the fifteen ways in which the white feet may be disposed, as well as the percentage of foot-marked animals of each color of horses, will be given at another time.

The hind feet are much oftener white than the fore (unlike the horse of nature, the horse of art has the fore feet white more frequently than the hind feet), and if one examines the cases where only the two hind feet are white, in a majority of cases the amount of white is the greatest on the left leg, the white extending further up. This is probably true also where only the two fore feet are white; but this is such a rare marking that I cannot state the fact from actual observation.

Here let me say that some combinations of foot-markings are so rare that if owners of horses kept records of them, they might sometimes be important data in the identification of lost or stolen horses. For example, a bay horse with only the right fore foot white, or one with the two fore feet white, the right one being white farthest up the leg, is so comparatively rare compared with the whole number of horses, or even of bay horses, that it would be an important factor in legal identification.

Second. Observations made on spotted horses show that a majority of them have more white on the left than on the right side. This shows itself in two ways. In the first place, if the amount of white is small, and if there is merely a white spot on the horse (other than on the face or just above the hoof), then such spot is oftenest on the left side. In the second place, if the animal is decidedly spotted, ("Calico," or "Pinto"), then the area of white (so far as could be judged by the eye in the examples observed) is greatest on the left side in a majority of cases.

Formerly spotted horses were fashionable, as they still are among barbarous or semi-barbarous peoples, and, indeed, among people of our civilization, in regions where horse-stealing is also fashionable. but spotted horses are now so unfashionable in the older States that it is not easy to find a sufficiently large number for extensive generalizations. So far as observed, however, the rule holds good, and I have not included in my figures those cases where several such horses seen together, and originating on the same ranch, might have a similarity of marking due to family heredity.

Third. Mules are rarely spotted, although such are occasionally seen, but I have never seen a foot-marked mule, and never had but one reported to me, that is, a mule with a white foot or white feet. This applies to mules with solid colors; spotted mules sometimes have white legs and feet.

Fourth. As to horned cattle my data are much more scanty and also less satisfactory. In the first place they are not foot-marked as horses are, but if white occurs, it is in quite another fashion. On the legs it is usually in spots, blotches, or patches, and such blotches or spots, I think, are oftenest on the front side of the leg, usually not extending to the hoof, ill defined, and very rarely in a clean, well-defined white ring or stocking, as we see so common with horses. Moreover, at agricultural fairs, where many breeds are exhibited, the numerical results of observations on spots are often vitiated because of the families or strains exhibited together and similarly marked by heredity. However, so far as my observations go, they point in the same direction, and I strongly suspect that the same rule holds good with cattle as with horses, and that with them also white occurs more frequently and in greater quantity on the left side than on the right, although my observations are too few to prove it by large numerical data.

Fifth. The same may be said with dogs, but here the occurrence of white feet and their disposition have no value in such an investigation, because white feet are a "fancy point" which is bred to in some common breeds. If the right and left are shown in dogs by color, I have not been able to verify it by numerical data, but it is strongly shown by the tail being carried on the left side, in the vast majority of cases. With some breeds this has long been a character (a "point," as breeders say), and even in breeds where this is not a "point," it is usually true in fact. It is not true, however, as has been sometimes stated, that dogs which carry their tails to the right are more liable to be afflicted with rabies.

Sixth. With swine, as with dogs, the number and disposition of white feet are of no significance in this connection, because with some breeds (as in the Berkshire) white feet constitute a "fancy point" bred to, and I have not been able to carry my observations to the relative areas of white on the two sides of spotted hogs in a sufficiently large number of cases to generalize from, but enough, however, to lead me to surmise that the rule holds good here too, and that swine have the most white on the left side.*

Seventh. From the observations made on the disposition of colors on our spotted domestic animals, it seems to me probable that, with each species, white occurs more frequently and in greater quantity on the left side.

And if so with domestic animals, why not with wild animals also? But here my means of observation have been far too restricted for generalization. The few specimens in menageries, the stuffed skins in museums, a very few spotted skins of sport-marked wild animals, have been too few to generalize from, and yet that few has pointed in the same way. The only wild species of mammal partly white to which I have had access in any number is the skunk. As is well known, these vary greatly as to the amount and the pattern of the white markings, and this determines the relative value of the skins in the market. In the skins I have examined, the majority had the most white on the left side; the number, however, is too small (only about sixty) upon which to base generalizations.

As the result of a long continued investigation (one by no means finished, I hope), I strongly suspect that it is a law of nature that mammals have most white on the left side, and that adventitious or sportive markings of white are most liable to occur on that side; that as color is one of the characters most sensitive to modifying influences, and consequently the first to vary if there is any cause of variation; that it is the first external indication which we have, showing a difference betweeen the right and left, a differentiation which culminates in the right handedness of man.†

Eighth. As to the more immediate cause, that the left side is the weaker side early suggested itself, and white hair is, to a certain extent, a sign of weakness; the hair of man, horses, and various animals whitens with age, and I think that usually the hair and whiskers of man and the hair of woman begin to be obviously gray on the left side first.

The relation of the color markings of domestic animals to bilateral symmetry has been the subject of discussion in late years, and from time to time the statement has been made and reiterated in various ways and shapes that one rule holds with wild animals and quite another with domestic ones—that whereas wild animals, if marked at all, are marked alike on the two sides, domestic animals are not.

My own conclusions are that there is no such difference of principle, that the actual differences observed are merely those of degree, and not of kind.

The disposition and kind of color-makings on wild animals are doubtless related to protection and ornament, both of which would apply to both sides alike, for if there is any reason why markings or dispositions of color on one side are either protective or ornamental, these reasons are equally strong for the opposite side, and a general bilateral symmetry of color follows as a necessity, although there is a continual tendency to vary toward irregular and unsymmetrical markings. But this symmetry is more apparent than real, more general in effect than special in detail. I have examined hundreds of skins of color-marked animals, tigers, leopards, cougars, and other species of the cat family, zebras, in fact *all* the skins of marked animals to which I have had access for many years, and I never find the bilateral symmetry ab-

* From the "Proceedings of the American Association for the Advancement of Science," vol. xxx., Cincinnati meeting, August, 1881.

* Unlike that of the dog, the curl of the pig's tail is as often on one side as on the other, and indeed the organ is carried on either side according to the taste or fancy of the wearer.

† There are numerous statements floating about on the sea of newspaper literature relative to the right or left handedness of animals being indicated in this or that way; that horses step the right foot forward first, that elephants use their left tusk most, by preference, and other statements of a similar character, but so far as I have been able to observe, I have not found one of these to be borne out by investigation.

solute in the details. The markings of the two sides of the animal resemble each other in a general way, the general effect is the same, but when compared spot for spot, stripe by stripe, the agreement is less complete than one would be led to expect from theory; the individual marks vary in every character except the most general. This is still more obvious if we compare different animals (of the same species) with each other. This is true even of spotted serpents, from the little spotted snakes of our own country to the formidable reptiles of Brazil and Africa.

Wild animals are sometimes spotted by sportive markings. These make the creature conspicuous to its enemies, and being the reverse of protective, such spots are quickly eliminated. All who have been in the far West know the zeal with which even the human hunter goes for a spotted bear or buffalo, or other abnormally marked beast. Nature tolerates only a limited amount of variation, but the individuals of a species vary just as widely as the external conditions of safety and sexual attractiveness allow.

In domestication, any irregularity of color-marking becomes protective, facilitating recognition and identity, and thus is of value to the owner of the property. Irregularly disposed spots and markings have had a protective value among stock owners ever since the days when Jacob "made the white appear," and claimed the "ringstreaked, speckled, and spotted cattle" as his own, and doubtless much longer.

With our modern breeders, fashion largely decides what colors are to prevail and how they are to be distributed. Where any color-markings are breeders' "points," they are symmetrically disposed; the white feet of Newfoundland dogs and Berkshire pigs, the broad white belt on the "sheeted" breed of cattle, and other breeds symmetrically marked suggest themselves. In such breeds the markings, *if bred to* (which really means "artificial selection"), are as symmetrically and as regularly disposed as are the color-markings of wild animals, under the operation of "natural selection;" more so than is the case with the skunk.

Where color-markings do not constitute breeders' points, they are then as irregularly disposed as are the sportive colorings of wild animals. The spotted bears and buffaloes (sports), and occasionally deer, are as irregularly marked as are the cows of our herds, or the calico horses seen in our streets. With wild animals, such sports are eliminated, as already explained. With horses, in countries where such markings are protective for establishing ownership, or where fashion or fancy creates a market, they are bred, and are then common; when unfashionable, calico horses are almost as rare as spotted bears.

Some breeds are irregularly spotted, like the Dutch ("Holstein") cattle and Poland-China swine. In such cases, the irregular markings become a "fancy point" of some value and are bred to, and in such cases will be spotted the prevailing color. But if fashion changes, so do the colors. We have a familiar example in the spotted breeds of Channel Island cattle changing to uniformity under the fashion for "solid colors" now prevailing.

With mongrel stock, if spotted and party-colored, as they are apt to be from their mixed ancestry, there is still a tendency toward bilateral symmetry in a majority of cases, as any one may easily prove by carefully comparing the markings on the two sides, the feet, the ears, the line on the back, etc., of a number of spotted animals. This is even true of a considerable number of calico horses I have observed, not so symmetrically disposed as the two sides on the markings of a zebra, to be sure, yet a disposal of marks as if there was an effort in the direction of bilateral symmetry.

Each of the points in this paper I purpose to elaborate more in detail at some future time, from data already at hand.

CANADIAN APATITE.

THE numerous openings made by prospectors and miners in the phosphate regions of the provinces of Ontario and Quebec have afforded excellent opportunities for the study of the Laurentian minerals and their mode of occurrence. The crystalline limestones of the Laurentian series are remarkable for their great extent and for the variety of crystalline minerals which they contain. They are interstratified with beds of dolomite, which sometimes contain a portion of carbonate of iron, and inclose serpentine, tremolite, quartzite, and a little white mica, but are generally less abounding in foreign minerals than the pure limestones. Several mineral species might be mentioned as marking bands in the stratification. Among these, there are apatite, chondrodite, pyroxene, magnesian mica, and graphite. Apatite or phosphate of lime is one of the principal features of the limestones of the Laurentian series. It is found in a variety of colors and shapes, sometimes in rare crystals disseminated throughout the veins; at others, in solid masses, in veins of great width. Sometimes it is in the form of prisms. These are generally rough, but often terminated, and always have their angles rounded. Apatite is generally associated with pyroxene, which has also been found in large crystals. It is sometimes found with phlogopite. In a crystal of the latter, about four inches in diameter, a crystal of apatite about a quarter of an inch thick and two inches long was found embedded, the axis of the prism being parallel with the cleavage of the mica. Rounded masses of calcite are often inclosed in the apatite, which in its turn is frequently in rounded pale green crystalline masses embedded in the coarse-grained limestone.

Apatite is used in the arts for the manufacture of phosphoric acid and phosphorus, and enters largely into the composition of certain porcelains. It is, besides, very extensively used as a fetilizer of the soil. Phosphates are among the minerals most essential to vegetation, and are removed from the earth in large quantities by growing crops. The importance of a supply of phosphates to the soil is made very evident by the fact that the mineral constituent of the bones of animals is for the greater part phosphate of lime. This material, whether in the form of bones, coprolites, or apatite, is seldom applied to the soil in its insoluble state, as it is then comparatively unavailable for the nutrition of plants. To render it fit for agricultural purposes, it is converted into a soluble salt, which is known as a superphosphate of lime. The process of conversion is as follows: In the insoluble mineral or bone phosphate, one equivalent or 71 parts of phosphoric acid is united to 3 equivalents of 28 parts each of lime, making the equivalent weight of the ordinary phosphate of lime 155. In order to reduce this to the soluble superphosphate, which contains one equivalent of phosphoric acid and one of lime, it is necessary to remove two-thirds of the lime, or two equivalents. This is effected by adding two equivalents, or 98 parts, of sulphuric acid, which form with this lime 136 parts, of sulphate. One hundred parts of ordinary phosphate of lime, therefore, require 63·2 parts of sulphuric acid to convert them into the soluble superphosphate with one equivalent of base. In this process, however, regard must be had to the foreign matters which accompany the phosphate, and which may also require sulphuric acid for their decomposition. Of these, the principal are fluoride of calcium and carbonate of lime. The former is always present in small quantities in bones, and in still larger amounts in many of the mineral phosphates, and requires for decomposition of 100 parts, 125 of sulphuric acid, while carbonate of lime, as an impurity, requires 98 parts of acid to decompose 100 parts.

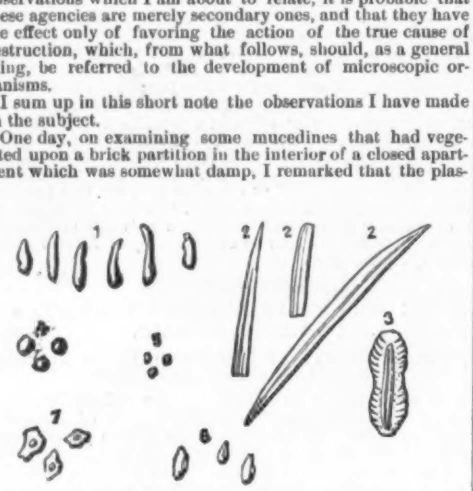
Of late years the increasing demand for phosphates as fertilizers has drawn attention to the use of the crystalline mineral phosphate of lime, or apatite, of which large quantities have been imported from Norway into England, and attention has recently been turned to the abundant supplies of this substance found in Canada, and large importations have recently been made from the Canadian phosphate regions into England. The present price for apatite in England is one shilling and five pence per unit, or about $30 per ton, for a first-class grade. Capital is slowly investing in the phosphate lands of Canada. Railroad enterprise is moving for the purpose of transportation, and the time is drawing near when the mining or quarrying of phosphates will be one of the largest and best-paying industries in Canada. The cost of production being small, but very little capital is necessary, and the large and continued demand fixes the price for which the mineral can be sold at such a figure that, as a profitable undertaking, not a doubt remains.—*Engineering and Mining Journal.*

MICROSCOPIC ORGANISMS AS DESTROYERS OF BUILDING MATERIALS.

POROUS materials, such as bricks of baked clay, are often observed to become friable or pulverulent to a variable depth on their exterior, and this occurs especially where the baking has not been sufficient. This species of caries, thus begun, gradually enters the brick to a greater and greater depth, and ends by reducing it to powder. Up to the present time this phenomenon has been attributed to the action of moisture, to alternations of heat and cold, etc.; but, from the observations which I am about to relate, it is probable that these agencies are merely secondary ones, and that they have the effect only of favoring the action of the true cause of destruction, which, from what follows, should, as a general thing, be referred to the development of microscopic organisms.

I sum up in this short note the observations I have made on the subject.

One day, on examining some mucedines that had vegetated upon a brick partition in the interior of a closed apartment which was somewhat damp, I remarked that the plastering exhibited blisters or bubble-like projections at certain points. On puncturing one of these, there issued from it a very fine red dust that had resulted from a pulverization of the brick. I at once thought of the presence of larvæ or of insects, and therefore looked for these, with a lens, among the debris. Finding nothing, I had recourse to the microscope, and, under a magnification of about 300 diameters, saw in the midst of the debris of the diatoms and silicious algæ that had belonged to the clay from which the brick was made, an immense number of living microscopic organisms. The greater part of these belonged to the types shown in the annexed figure (and which were drawn by aid of the camera), micrococcus, unicellular algæ, amœbæ, and ciliated species of algæ, which were moving with extreme rapidity. Some of them were in the act of budding.



1. Unicellular Algæ. 2–3. Silicious and Diatomaceous Algæ. 4. Micrococcus. 5. Spores of Algæ. 6. Myxomycetes. 7. Amœbæ.

The existence and propagation of these proto-organisms in such an environment, beneath a continuous layer of plaster 5 to 6 millimeters thick, has a right to surprise us; and yet this is not all. Having cleaned the rotted surface of the bricks with a stiff brush, I drilled a hole therein about thirty millimeters in depth, and examined under the microscope the dust taken from the bottom of the cavity. The same organisms showed themselves, but not in so great a number (about 100 per square centimeter of the preparation, instead of 150 that were met with in the first observation). All the bricks that exhibited the symptoms of deterioration just described offered the same microbes in varying number.

The microscopic preparation was made, in each case, by dropping a pinch of the dust to be studied into a few drops of *pure water* or alcohol, and taking a drop of the supernatant liquid.

The conclusions to be drawn from these facts are numerous. They show us, in the first place, that germs and spores may be preserved, so to speak, indefinitely, within surroundings that are eminently protective to them, and where no one up to the present time had dreamed of going to look for them.

Hence is explained the utility of the disinfecting processes that are employed in apartments, hospitals, or stables in which cases of contagious diseases have occurred. The scraping and kalsomining of walls are the only prophylactic means that have, up to the present time, a known effect. It may be easily seen that these operations remove from the walls the permeable layer in which the parasitic germs have been enabled to establish themselves, and multiply therein in a different stage of development from that under which they determine well known morbid effects.

Besides, these observations establish the fact that the role of the infinitely small is to be taken into account in the duration of buildings and other structures. We might possibly seek here the reasons for the rapid destruction of numerous Semitic monuments built of slightly baked or merely sun-dried bricks by the Assyrians and some other ancient peoples.

Finally, this same cause may possibly play a role in the disintegration of schistose rocks, and of the agglomerates or clods that enter into the composition of arable soils.—*M. Parize, in La Nature.*

A CURE FOR STIES.

Among the most troublesome and often noticed eye affections are what are known as hordeolum, or common sty. Dr. Louis FitzPatrick, in the *Lancet*, differs from some of his professional brethren, who persist in ordering the application of poultices, bathing with tepid water, etc. These no doubt do good in the end, but such applications have the great disadvantage of prolonging the career of these unsightly sores, and encourage the production of fresh ones. Dr. FitzPatrick has found, after many trials, the local application of tincture of iodine exert a well marked influence in checking the growth.

This is by far preferable to the nitrate of silver, which makes an unsightly mark, and often fails in its object. The early use of the iodine acts as a prompt abortive. To apply it the lids should be held apart by the thumb and index finger of the left hand, while the iodine is painted over the inflamed papilla with a fine camel hair pencil. The lids should not be allowed to come in contact until the part touched is dry. A few applications in the twenty-four hours is sufficient.

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